THE EAST AFRICAN AGRICULTURAL JOURNAL

Issued under the Authority of the East African Governors' Conference and published every three months—July, October, January, April. Volume consists of four issues (commencing July issue).

FOREWORD

In our main article Mr. Moreau deals with a crop to which scientists in East Africa have so far devoted all too little attention, probably because the common spud is a comparatively easy crop to grow, after a fashion, in our highlands and until recently has been free from any major disease. The time has now come, however, when this neglect can no longer be allowed if this crop is to achieve and maintain its rightful place in local diet. Mr. Moreau's article is an interesting example of the snowball nature of scientific investigation; that is to say, it started as a simple enquiry into the location and elevation of the potato-growing areas of East Africa and from that developed into a keen analysis of potato behaviour in the tropics as recorded in the available scientific literature. The article gives an admirable review of the climates and seasons of East Africa as they concern the needs of the common potato, *Solanum tuberosum*, and goes into the possibility of finding other species better suited to our needs from amongst the many new species discovered in South America by Russian and British scientists in recent years. The result is to debunk two commonly held beliefs about the potato and to show the wide field for scientific enquiry that lies open for the research worker, particularly the plant physiologist. Thus it is commonly stated in agricultural literature that potato yields are low in the tropics because of high temperatures and the comparatively short period of daylight to which the crop is subjected: but Mr. Moreau shows that, assuming the farmer knows his job, excellent yields can be obtained in parts of tropical Africa, even when judged by European and American standards. Another theory which he shatters is the belief that some of the newly discovered species from the Andes are likely to be an improvement on *Solanum tuberosum* because of their supposed greater tolerance to high temperatures. After reading Mr. Moreau's article one is left with the feeling that *Solanum tuberosum* or the common potato is a wonderfully adaptable plant which, in spite of its known disabilities, is unlikely to be replaced in East Africa by any other potato species for some time to come. The possibility that, as a result of the present investigations in Kenya, a variety of *S. tuberosum* may be found which is highly resistant, or almost immune, to late blight adds support to this view.

The article by Dr. Nattrass on seed-testing for farmers is of particular significance at this time when East Africa is attempting the production of vegetable and other seeds previously imported, a venture which if successful might well develop into a valuable export business in addition to supplying our own needs. It is now obvious that one of the main problems facing the United Nations for some years after the war will be the restoration of European agriculture, particularly by the provision of seeds and live stock. In this work of reconstruction East Africa will be able to play no small part if she can supply high-quality seed in quantity, and the quantity needed will be very great indeed. The ability to supply such seed depends primarily on proper growing and grading, but this must be followed by carefully conducted tests to determine the real value of the seed. Such tests must be conducted in properly equipped and staffed laboratories and it is therefore good to learn that seed-testing laboratories are about to be established in Kenya and Tanganyika. No farmer should have any doubts as to the need for such establishments after reading Dr. Nattrass's article.

The public's conception of the privileges and obligations of landowners has undergone considerable modification during the present generation and is likely to change still further as a result of the war, particularly as it concerns the individual owner's right to do what he likes with his land. The Uthwatt Report, which is reviewed in this number by Mr. Liversage, may not represent the views of the general public in Britain, but it does represent the considered views of a responsible and informed body of opinion towards the problem of future land-planning. Such planning must inevitably interfere with the existing rights of property owners. Two kinds of interference are recognized in the report: firstly the placing on the owner of an obligation to use his land in a prescribed manner, and secondly the com-

pulsory acquisition of property by the State. The first type of interference we are already familiar with in connexion with necessary Government measures for the prevention of soil erosion, forest destruction and bush fires. The justifications for the second type of interference may not always be obvious and for this reason the findings of the Uthwatt Committee should be of particular interest to our readers in Kenya, where a Bill has recently been published "to provide for the acquisition by the Crown of land for settlement and other public purposes and to establish a Board which will have wide powers of controlling dealings in land".

Mr. Masefield, in his article on soil erosion around buildings, deals with an aspect of soil work which is commonly neglected by builders in the tropics. Who amongst us has not been shocked by the deep gullies frequently to be seen around churches and other large buildings of European type in East Africa? And yet with a little care in the choosing and laying out of building sites this type of erosion could be prevented. Where it has already begun, the obvious remedy, a grass cover, is not always easy to carry out. Nevertheless it can be done and the author indicates the different ways in which the problem can be attacked.

Mr. Culwick's article on the "Fundamental Economics of Export Crops" in the October number has led to interesting comments. Unfortunately the letters on the subject arrived too late for inclusion in this number and will be printed in April.

CORRECTIONS TO OCTOBER NUMBER, 1943

Page 64, under Fig. 2 *Coryza schimperi* should read *Conyza schimperi.*

Page 65, Table II, col. 4, against *B. dictyoneura* for 154.5 read 154.4.

Page 68, "Mead" should have appeared over the initials of Mr. W. V. Harris.

EAST AFRICAN AGRICULTURAL RESEARCH STATION

It is notified for general information that as from 1st January, 1944, the above Department will be known as the "East African Agricultural Research Institute".

In spite of all signs of interest and in spite of the admirable hands in which, as a general rule, the direction of science lies, it could not be claimed that African development has so far been greatly influenced by the results of scientific research. In a continent which has been developed almost wholly in the twentieth century, there might have been more room than elsewhere for such influence, but this has not been the case; economic development has taken the lead and often chooses the wrong turning. Science follows, but the pace is laboured, and falling behind she is neglected. Often she has to follow along the wrong path for some distance before beckoning development back to the direct way. Roads and rails have been built before there were accurate maps on which to mark them; crops have been introduced and grown under all kinds of conditions, regardless of the suitability of the soil; inter-tribal warfare has been stopped; we seek to increase the native population, improve their standard of living, and economic status, and native stock multiplies to such an extent that the earth is denuded of vegetation and the soil may be washed away to sea by the next storm. A development based on a real understanding of Africa's potentialities has hardly yet begun, and will be impossible until the necessity of scientific knowledge is recognized.

Dr. E. A. Worthington in *Science in Africa.*

PROTEIN SUBSTITUTES FOR LIVE STOCK

We have been very much interested in the work of Dr. Benesch and his collaborators at Leeds University on chemical substitutes for dietary protein. We learn from him that work on this subject has been going on for many years in America, Germany, Rhodesia, and this country, and it is now established that cattle are able to replace a certain percentage of their protein intake by a simpler nitrogen compound, such as urea, ammonium acetate, ammonium bicarbonate, glycine, and other similar substances. Under war-time difficulties of obtaining sufficient protein supplies for live stock, the question of nitrogen assimilation assumes a new importance. How the actual conversion of nitrogen in, for example, urea, to the proteins of milk and meat takes place in the body of the animal has not been fully investigated as yet, we understand, but the influence of micro-organisms in the digestive tracts of the cattle has a direct bearing on the subject. The main fact is that Dr. Benesch tells us how experiments on animals have shown that "amide"-like substances such as urea and glycine can actually be utilized in the growing ruminant under certain conditions in place of protein for the production of body substances.

(*Chemistry and Industry*, Vol. 61, No. 1, p. 2, 1942.)

THE CLIMATIC BACKGROUND TO THE PROBLEM OF POTATO VARIETIES FOR EAST AFRICA

PART I

By R. E. Moreau, East African Agricultural Research Institute, Amani

I Introduction.
II *Solanum tuberosum*: its limitations and its origins.
III The *S. andigenum* group and its climate.
IV The East African potato-growing areas, seasons and rainfalls.
V *S. tuberosum*: some recorded yields and yield-factors.

I—Introduction

A general impression has recently been stated in somewhat exaggerated form by Driver (1941): "It has always been difficult, if not impossible, to grow potatoes in tropical countries". It is true that at low latitudes potato-growing is local and there is general dissatisfaction with yields. Especially because of the potential value of the potato as a native food-crop, there is a movement to try to extend the areas in which potatoes are grown in East Africa and to improve yields by importing, selecting and breeding varieties that are better adapted. It seems, therefore, appropriate to examine the present production and the prospects of improvement in relation to certain climatic factors that are regarded as of cardinal importance to potato yields. So far as possible this inquiry is concerned with the direct physiological effects of climate on the potato. No one can afford to neglect the disease problems; but they tend to be world-wide, rather than peculiarly tropical, and to that extent do not demand special attention from us here.

The data available for this inquiry are scanty, but they suffice, I think, to give some guide, however provisional, to policy. At least they provide correctives to some opinions that have been authoritatively disseminated: on the one hand the rosy prospects of expanding potato cultivation in the tropics (Anon., 1936): on the other hand the gloomy view that because of the invincible factor of short daylight "our" potato can at low latitudes yield only a fraction of what it can elsewhere (Bald, 1941).

The frequent use of the name *Solanum tuberosum* in the following pages lays me open to a charge of pedantry that I may as well forestall. In the first place, sweet potatoes (*Ipomaea batatas*) are so important a crop in many hot countries that it is necessary to avoid confusion with them. "Irish potato" is the name usual in the U.S.A. for our domestic potato: elsewhere in non-European literature "European potato" has been used: in East African departments there is a tendency to standardize "English potato". All these names are open to objection on historical grounds. Moreover, since the discovery that "our" potato is only one of several tuberous species of *Solanum* that are locally important food-crops and that are mentioned in this paper, the name *Solanum tuberosum* is often the most convenient as well as the most precise to use in the present discussion.

Except where otherwise stated, all the details of African potato-growing are derived from unpublished information kindly supplied in response to my inquiries. For this help thanks are due to the Department of Agriculture, Union of South Africa, and to Dr. J. C. Hopkins (Southern Rhodesia) as well as to officers of the East African Departments of Agriculture. Moreover several of the latter, several of my colleagues, and also Group Captain A. Walter have been good enough to read my draft critically from their various points of view. Finally I have to thank the British Meteorological Office and the British East African Meteorological Service for the climatic data used, except those for which specific published references are quoted.

II—Solanum tuberosum: *Its Limitations and its Origins*

The indifferent success of *Solanum tuberosum* as a food-crop outside a relatively small proportion of the earth's surface has been ascribed to the following of its limitations, separately and in combination:—

(1) It will not thrive in heat. "High air and soil temperatures are incompatible with healthy and normal growth" (Stuart. 1928).

(2) It "yields best under the long summer day of temperate latitudes, giving a very decreased yield under the 12-hour day of equatorial and tropical latitudes" (Hawkes, 1941: cf. Bald, 1941, and Driver, 1941).

(3) It needs a moderate rainfall. "In the best potato-growing regions of the U.S.A. the average total rainfall during the period between planting and harvesting varies from 12 to nearly 18 inches. Much rain late in the growing season is especially dangerous" (Stuart, 1928).

(4) It will not stand frost.

(5) It is a prey to devastating diseases.

(6) Its tubers do not stand storage well in hot weather.

Limitations (1) and (2) are obviously of prime and immediate significance to any breeder of potatoes for the tropics. Point (3) is not so important: the effects of low rainfall during the growing period can often be corrected by siting or by irrigation, and the effects of too much can in practice be to some extent off-set by special attention to drainage (cf. Paravicini, 1923). Limitation (4) is of very minor importance to East Africa. Limitation (5) is not a peculiarly tropical problem and in any case is not here our concern. Limitation (6) certainly is important to the tropics, but in the matter of improved storage quality much help may be expected from India, where the carry-over of "seed" through the summer of the Indian plains is a pressing problem (Pal, 1940).

From the foregoing it appears that the limitations imposed by temperature and light-ration demand especially close attention in any attempt to improve yields in the tropics. These limitations, and also that connected with frost, plant-breeders so far have not been able to transcend, while their success in breeding for disease-resistance has been moderate. In seeking the reasons for their failure it is necessary to consider the origin of the stock from which the domestic potato was developed. On this subject there are two schools of thought. They agree in stressing the very meagre extent of the material the breeders had at their disposal and the dates of its introduction: they differ on important points of geography. One view, strongly advocated of recent years by the Russians (Anon., 1936), who must be regarded as the pioneers of new breeding developments, is as follows:—

(*a*) A few tubers were introduced by the Spaniards into Europe about 1565 from the great centre of aboriginal potato culture in Peru-Bolivia, at latitudes 10-20°S. and in the comparatively cool dry climate of the altoplano of the Andes.

(*b*) Other potatoes, which were multiplied rapidly, especially in Ireland, were introduced by English seafarers about 1580 from Chile, perhaps from about 40°S., in the Chonos Archipelago, or the island of Chiloe, where the climate is moist and equable.

(*c*) From before 1568 until the 1930's the only fresh infusion of any importance was a variety of *Solanum tuberosum*, which came in via the U.S.A. (1851) under the name "Rough Purple Chili" and was naturally regarded as originating in the latter country (cf. also Salaman, 1926), or even specified as "indigenous" there (Hunter and Leake, 1933).

On this view Chilean stock was regarded as predominating heavily in the make-up of the modern domestic potato varieties: and the maritime Chilean environment certainly accords with the observed present adaptation of the plants cultivated in Europe.

The other view, that introduction (*b*) as well as introduction (*a*) was a High-Andean stock, is an old one (Stuart, 1928) and has recently received the specific endorsement of Salaman (1938). Moreover he now ascribes (*c*), the 1851 infusion, to Panama, regarding its varietal name of "Rough Purple Chili" as of no geographical significance. It is, of course, a necessary implication of this view that our domestic potato originated in a comparatively rigorous and short-day climate (to be referred to in more detail later) and the assumption that it has become adapted to the "oceanic" long-day climate of north-western Europe postulates sweeping changes in its "constitution".

It has been contended that such changes are feasible as a result of centuries of selection, conscious and unconscious, for a type of potato that would yield most heavily in the climate of north-western Europe. The multiplicity of potato varieties that have been recorded, and the hosts more that have not been separately described, have been obtained by combining and re-combining the characters carried by the originally imported ancestors, which were so very few. In the process many genes and characters were deliberately discarded by the breeders and many must have dropped out unknown to them. The genes lost are mainly dominants and so are lost for ever. The domestic potato that we know is largely

composed of recessive genes (Anon. 1936). The number of genes lost may reach a hundred (Salaman, 1938), some index to the number of characters. The final results, the varieties so deservedly popular at the present day, have been developed and propagated above all in the northern part of the British Isles. In fact the neighbourhood of the Scottish Border might perhaps reasonably be taken as typifying the climate to which the modern domestic potato is above all adapted. There we have in the growing period days reaching a maximum of 17½ hours between sunrise and sunset, with, of course, the long northern twilight. The mean temperature experienced by the plants is about 53°F., with no monthly mean maximum exceeding 68°F. Incidentally it may be remarked that the genes making for frost resistance, if any existed in the stock that reached Europe, would presumably be amongst those lost through inadvertence. No one in northern Europe would deliberately select them out.

III—The S. andigenum *group and its climate*

The Russians were the first to recognize the full implications of the paucity of genes that potato selection had left at the breeders' disposal. The Soviet authorities had bumped especially hard against two of the domestic potato's limitations, its inability to stand either frost or heat, when they tried to extend its cultivation in the vast territories of the U.S.S.R., most of which have so "continental" a climate. As one of the Russian geneticists put it (Anon., 1936), "Potato breeding was stewing in its own juice, using for the introduction of new varieties always the same old parents in innumerable combinations". The Russians brought fresh minds to the problem: they did what it seems incredible now, after the event, that no one should have done before; they organized a series of expeditions to the home of the potato in South America, to look for new varieties that might be useful for introduction and cross-breeding. They found an astounding wealth of material; and although they were followed by Swedish and American and German expeditions, when at last the Imperial Agricultural Bureaux sent an expedition in 1939 there were still many new forms for them to discover. These have been collected for study at Cambridge. The results of these various expeditions have been described in two publications of the Imperial Bureau of Plant Genetics, from the earlier of which (Anon., 1936) most of the points in the following paragraph are extracted.

It has now been established that from Bolivia to Mexico the local potatoes are "entirely different from the common domestic potato." "In the place of the single species *Solanum tuberosum,* under which the cultivated potato has always been known, a whole series of distinct species was established, differing in good systematic characters, and as it was shown later in chromosome number." On the mainland of South America edible potatoes of various species were found to be cultivated from sea level to 13,000 ft., where they were exposed to "constant frosts". In all Andean countries the potato most extensively grown is one named *S. andigenum.* It is there represented by hundreds of varieties, both wild and cultivated, flourishing at altitudes of 6,000 to 13,000 ft. and capable of giving fertile hybrids with our domestic *S. tuberosum. S. andigenum* and some other species have so close an adaption to a short day that in higher latitudes they will not produce any tubers. In some of these species resistance to wart disease (*Synchitrium endobioticum*) and to blight (*Phytophtora infestans*) has been claimed. One species, *S. phureja,* has a notably high protein content in the tuber, about 14 per cent compared with only about 2 per cent in *S. tuberosum* (Thorpe, 1924), a point of no little importance when native African nutrition comes into question; moreover it has been shown that the high-protein content can be further increased in hybrids. A useful summary of the "resistances" and other good qualities claimed for the new species of *Solanum* has recently been given by Driver (1941), whose bibliography contains, however, no reference later than 1938.

Although, as stated above, edible potatoes were originally reported as being cultivated in the Andean countries from sea-level to 13,000 ft., it has since been stressed by Hawkes (1941) that it is necessary to distinguish the areas of indigenous cultivation from those where the potato is "an introduced crop only maintained by special processes". In fact "the paramo and puna steppes are virtually the only areas" where potatoes can be "maintained in a healthy state with no disease control or introduction of fresh seed from other areas". There "the best varieties, grown at optimum altitudes (± 12,000 ft.) . . . give yields little inferior to the European domestic varieties". Most of the "non-indigenous plantations", apparently of all species, lie between 6,000 and 9,000 ft. Growers at altitudes below about 8,000 ft. have, owing to the prevalence of disease and the high temperatures, to get fresh seed at frequent intervals from the higher mountain areas, and it is interesting that in Colombia (within 10°

of the Equator) potato-growing does not extend below 6,500 ft. and is generally confined there to altitudes of over 8,000 ft. The potentially valuable *S. phureja* does best at lower altitudes than the rest of the Andean potatoes, in fact round 8,000 ft. No particulars of its yields or the extent of its cultivation seem to have been given by Hawkes or others.

It is of incidental interest that the zones of "indigenous" and "non-indigenous" potato cultivation outlined by Hawkes correspond pretty closely with the Temperate and Subtropical Zones previously delimited by biologists working independently on the birds, mammals and plants of the Andean countries (Chapman, 1926).

It is unfortunate that the climate of the Andean countries is poorly documented, especially at the high levels in which the cultivated potatoes are really at home; and it is also unfortunate that the Imperial Bureau of Plant Genetics publications on the Andean potatoes give no temperatures. We know that the climate is a comparatively rigorous one, dry and cool. "It was probably only the discovery of the potato that enabled the earliest Indian arrivals to maintain themselves on the inhospitable altoplano of Peru and Bolivia" (Salaman, 1937).

The optimum temperatures for *S. andigenum* are typified by those at La Paz and Ollaque, both in Bolivia close to 12,000 ft. There during the growing season, November–April, the monthly mean temperatures vary as follows:—

Monthly means, between 43 and 53°F.
Monthly mean maxima, between 61 and 66°F.

Three localities at about 11,000 ft., Huancayo, Cuzco and La Quiaca, have monthly means all between 52 and 55°F., but mean maxima appreciably higher than La Paz and Ollaque, viz. between 64° and 74°F. The only two stations available at about the lower limit of fully healthy "indigenous" cultivation, viz. Sucre at 9,344 ft. and Arequipa at 8,040 ft., have more cloudy, less extreme, climates, with maxima actually lower than those recorded at Cuzo and La Quiaca. The Sucre and Arequipa records run:—

Monthly means, between 55 and 58°F.
Monthly mean maxima, between 63 and 69°F.

The foregoing data, considered along with those given by Chapman (1926), Gilson (1939) and Rudolph (1936), show that, during the growing period in the areas where the *S. andigenum* group does best, no monthly mean temperature exceeds about 53°F. and at the lower limit of the fully healthy potato cultivation no mean exceeds 58°F. The data for maximum temperatures are more difficult to interpret, but it is clear that mean maxima only exceptionally exceed 70°F. anywhere in the "good" areas. Four species, *S. antipoviczii, S. commersonii, S. chacoense* and *S. kesselbrenneri,* have been found experimentally "to form tubers readily at temperatures above the optimum" for the *S. andigenum* group (Imp. Bur. Plant Genet. *in litt.*). *S. phureja,* at its stated optimum of 8,000 ft., much lower than the other species, is exposed to maxima of about 70°F. and means not exceeding 58°F.

IV—The East African Potato-growing Areas, Seasons and Rainfalls

According to information furnished by the Agricultural Departments, the "commercial" areas and cropping-seasons are as shown below. Almost all the potatoes in East Africa appear to be grown on rain without the aid of irrigation, even where, as on Kilimanjaro, that is well-established general practice.

Northern Rhodesia

Along the railway line, mainly from Choma to Broken Hill (i.e. about lat. 17 to 14°S.) at altitudes between about 3,200 and 4,500 ft. Also at about 5,600 ft. near Abercorn (lat. 9°S.). Main crop planted November, harvested March. Irrigation crops planted July–August, harvested November–December; also some planted March.

Nyasaland

Chiefly on the "island" mountains at 3,000-5,000 ft. in the Southern Province (15 to 16°S.), 3,500-5,500 ft. in the Northern (10 to 15°S.), and especially at about 4,500 ft. Grown "quite successfully" on a small scale in one district (15° 30′S.) down to 2,000–2,500 ft.

Main crop planted at the beginning of the rains, late September–early November in the south, later in the north, and harvested after about four months. Dry-season crops are planted in fertile valley-bottoms with high water-table in March and again in July.

South Tanganyika

In the mountains round the head of Lake Nyasa and northwards to the eastern edge of the Iringa District (Dabaga), between 6,000 and 8,000 ft.

Two plantings: (*a*) in September, harvested in January-February, (*b*) about February, harvested June. Planting in September, which is fully two months before

the real rains break, can only be done in mountain areas that get a good deal of light rain and mist from September onwards.

Central Tanganyika

Uluguru Mountains, regularly successful only at 5,500-6,500 ft. on the comparatively dry west side. Main crop, planted late October takes five or six months to mature, exceptionally long for an East African locality. Potatoes grown on the wetter north and east are "liable to sudden epidemics and disasters".

North Tanganyika

(*a*) *West Usambara Mountains.*—Mainly in north-west and centre 4,500-6,000 ft. but some down to 3,500 ft. Reasons for poor success in the east uncertain but apparently climatic. In the north, two planting seasons, November–December and March–April, with harvests February–April and July–September. In the centre, where the rainfall is differently distributed, planting only in March–April.

(*b*) *Kilimanjaro.* South-west, central (Old Moshi to Marangu) and eastern slopes, mainly 5,000-6,000 ft. but extending throughout 3,500-7,000 ft. Two plantings:—

(i) October–November, harvested March–April, produces the local main crop in east, light crops elsewhere.

(ii) May–June, harvested October–November, produces the main crop in south-west and centre, light crop in the east.

(*c*) *Mount Meru.* Western slopes, mainly 5,500-6,500 ft., some down to 4,700 ft. Plantings November and June-July, harvested February-March and October-November.

Kenya

(*a*) East side of the Aberdares, Kikuyu to Nyeri, 6,000–8,500 ft., and west side, Ol Kalou to Thomson's Falls, 6,500-7,000 ft. Two plantings, March harvested July, and October–November harvested February–March.

(*b*) West side of the Rift Valley, Elburgon–Molo, 8,000-8,500 ft. One planting only, April–May, harvested September onwards.

Uganda

Mainly in Kigezi and Toro at about 6,000 ft. and in Bugishu (at the western foot of Elgon), but "potatoes are being increasingly grown around the towns and quantities are produced near Kampala and Jinja", i.e. at about 4,000 ft. In Bugishu "at levels below 5,000 ft. the potatoes mature in 2-3 months. Yields are low and tubers generally small. Above 5,000 ft. maturity is slower with bigger yields and larger tubers. The average maturity period appears to be 4-5 months" at these higher levels. Growing periods centre round the seasons of heaviest rain, on the whole March–June and September–December.

The limits explicit or implicit in the above statements are by no means all due to climatic causes. Some of them are due to shortage of people willing to grow potatoes at the ruling prices, or to lack of land. This last certainly determines the upper limits given for Kilimanjaro and Nyasaland, and probably also for Kenya east of the Rift, where cultivation extends up to the boundary of the forest reserve. On the other hand there is reason to believe that the lower limits cited are for the most part climatically determined.

Rainfall

The planting seasons for nearly all the potatoes grown in East Africa are determined by the onset of the rains. Only in Northern Rhodesia and Nyasaland are crops of importance raised on ground water. The average amounts of rain received monthly by respective potato crops in the chief areas are shown by the rainfall records extracted in Table 1. The main crop periods are shown in black figures, subsidiary in italic figures. In Uganda a main crop is not distinguishable on the information available. I am well aware of, and indeed have stressed (Moreau, 1938), the objections to using meteorological averages for agricultural purposes; moreover, the agricultural value of the rainfall will of course depend not only on the total recorded but also on its day-to-day and hour-to-hour distribution and on the nature of the soil. Nevertheless, for the present purpose the average monthly rainfalls do give useful bases of comparison.

It will be seen that in Kenya east of the Rift the potatoes of the main cropping period may expect 20-24 inches of rain, and west of the Rift 27-35 inches. By standards in other countries the latter should be ample and the former sufficient, though in Australia 20 inches of rain during the growing period is regarded as "close to the minimum necessary under subtropical conditions" (Bald, 1941).

The subsidiary cropping period in Kenya, which is said to be nearly as important as that of the "long rains", does not come off nearly so well for moisture. Apparently not more than 8-15 inches of rain can be reckoned on—no more than the crop receives in Lincolnshire, with much lower temperatures and, presumably, evaporation. Thus it may well be that the yields of the October–February crop in Kenya suffer from lack of moisture.

TABLE 1

MEAN MONTHLY RAINFALL (Inches)

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
KENYA, EAST OF THE RIFT												
Kiambu (Boma) ..	*1·6*	*2·0*	**5·1**	**9·2**	**5·9**	**2·2**	**0·9**	1·0	1·2	*2·7*	*6·0*	*3·1*
Kikuyu (K.U.R.) ..	*1·3*	*1·9*	**4·3**	**8·1**	**6·5**	**1·2**	**0·7**	0·6	1·1	*2·0*	*4·3*	*3·2*
Kabete (Scott Labs.) ..	*1·9*	*1·8*	**4·9**	**7·8**	**6·3**	**1·9**	**0·5**	1·0	1·1	*2·7*	*5·1*	*3·0*
Nyeri (P.W.D.) ..	*1·6*	*1·7*	**2·7**	**7·2**	**7·1**	**1·4**	**1·4**	1·4	1·2	*3·7*	*4·3*	*2·8*
Thomson's Falls Ol Viron)	*1·1*	*1·9*	**2·3**	**3·7**	**6·7**	**6·2**	**5·4**	7·6	4·5	*1·3*	*1·5*	*1·6*
KENYA WEST OF THE RIFT												
Molo (K.U.R.)	1·5	2·1	4·0	**7·0**	**6·1**	**5·0**	**5·6**	**7·2**	**4·0**	2·8	3·6	2·6
Elburgon	1·1	2·1	3·4	**5·5**	**5·1**	**3·1**	**5·2**	**4·9**	**3·0**	2·5	2·8	2·2
KILIMANJARO—												
West : Kibosho ..	*3·0*	*3·8*	*11·2*	*27·3*	**37·6**	**10·6**	**4·9**	**2·4**	**1·6**	**2·0**	*3·6*	*3·5*
Central : Old Moshi ..	*1·8*	*2·3*	*6·2*	*17·0*	**15·0**	**4·4**	**1·1**	**1·3**	**0·7**	**1·2**	*2·4*	*3·5*
East : Rombo	**2·7**	**4·2**	**8·1**	**11·3**	*5·4*	*1·4*	*1·4*	*2·0*	*1·7*	*3·8*	**11·3**	**8·6**
USAMBARA—												
Lushoto	2·7	3·3	**5·5**	**9·2**	**6·1**	**2·3**	**1·4**	0·7	0·4	1·3	3·8	4·1
Lwandai	**10·2**	**4·2**	*7·0*	*6·4*	*3·7*	*0·6*	*0·1*	0·5	0·9	2·0	**5·8**	**13·5**
SOUTH TANGANYIKA—												
Mufindi	*10·8*	**10·0**	**16·8**	**20·3**	**9·4**	**3·2**	0·9	0·9	*0·8*	*0·4*	*2·1*	*8·0*
Dabaga } From	*5·2*	**5·5**	**11·2**	**27·2**	**9·0**	**0·7**	2·9	4·5	*1·3*	*7·2*	*10·3*	*3·8*
Tandala } Paap	*9·8*	**9·0**	**15·3**	**7·5**	**3·6**	**0·0**	0·0	0·3	*0·5*	*0·4*	*4·0*	*9·3*
Bulongwa } (1934)	*9·4*	**8·6**	**12·2**	**6·0**	**2·5**	**0·0**	0·0	0·0	*0·0*	*0·8*	*5·1*	*13·8*
UGANDA—												
Kampala	1·8	1·6	*6·9*	*7·4*	*4·5*	*2·1*	2·1	2·9	*4·8*	*4·6*	*3·4*	*3·8*
Kabale	2·1	3·1	*5·2*	*4·4*	*3·0*	*0·7*	0·9	1·3	*3·7*	*4·2*	*3·8*	*2·6*
Mbale	1·0	2·3	*3·4*	*6·4*	*6·3*	*4·8*	4·3	5·7	*4·4*	*3·3*	*2·5*	*1·5*

On Kilimanjaro rain for both crops is more ample than in Kenya areas, even though for the west and central subsidiary crops the heavy April rains, coming right at the end of the growing season, be discounted. The shift of the main cropping season as one travels round the south-east side of the mountain is interesting. At Rombo, on the east, what are elsewhere on the mountain the most rainy months provide less than 12 inches of rain (plus that which falls at the very end of the growing season); and that suffices for what is described as a "light" crop only. This strengthens the suspicion that the Kenya "short rains" plantings may as a rule suffer in yield from insufficient moisture.

In Usambara and South Tanganyika the main crops get 30-60 inches of rain. It is interesting that round Lushoto there is only one potato season, the "long rains"; it may be that the "short rains", providing barely 14 inches November to February inclusive, are not enough for the crop. However, at Lwandai a crop is raised on about 16 inches, apparently with a wetter soil to start with. In South Tanganyika, it is most astonishing, in the face of the rainfall records, that a planting can be made in September, even if only "in mountain areas which get a good deal of rain and mist". Except at Dabaga it would seem that the potatoes go into thoroughly dry soil in September and get measurable rain only in the latter half of their growing period, with, however, an eventual total of over 20 inches.

In Northern Rhodesia the rain-grown crop can reckon on a good 25 inches; while, owing to the very marked nature of the dry season, growth between March and November is impossible without irrigation.

Uganda potatoes grown in Kigezi and Elgon probably receive better rains than are recorded at Kabale and Mbale (Table 1), the only local stations for which records are available. But it seems probable that the March-planted potatoes grown round Kampala get barely enough rain and those planted in September do not come off so well anywhere as those planted in May. Shortage of moisture, apart from any other factor, might operate against a good average yield in Uganda.

The foregoing statements and tentative conclusions must be taken with the proviso that the effect of rain is modified, not only by the nature and the time-distribution of its fall, but also by the prevailing humidity of the air, the degree of cloudiness, the nature of the soil and its moisture content at the time of planting. "In good, fibrous, cloddy soil potatoes appear to succeed well with little water during the growing period, provided that such soil has

a good supply at or before planting" (F. Hawkins *in litt.*). Unfortunately such soil is rare in East Africa. Some volcanic soils are, however, retentive; and even at Lushoto an excellent yield was obtained in an experimental plot that was planted when the soil was saturated, towards the end of the "long rains", and received only 4.1 inches during growth.

V—Solanum tuberosum: *Some Recorded Yields and Yield Factors*

Since north-western Europe is the home of most of the potato varieties planted in the Tropics—though in the old potato-growing areas of India and the Dutch East Indies local varieties are much used (Pal, 1940; Paravicini, 1923; Buyze, 1929)—the following yields (Wallace, 1941) can be taken as the standard of comparison:—

(i) Holland and Belgium, the best countries of all, 8 tons per acre.

(ii) United Kingdom and Germany, 6 tons per acre. In the U.K., yields of 8 tons are obtained in the best areas: "yields of 14-16 are heard of occasionally, but such, if obtained, are very exceptional". U.K. seed rates are of course, high. They have risen from the 15-18 cwt. per acre cited by McConnell (1930) to an average of 20 cwt. (Wallace, 1941), so that the average 6-ton yield is only six-fold.

Commercial yields in the U.S.A. differ strikingly from those quoted for Western Europe. The over-all average is given by Wallace as "just under 4 tons", but it is depressed by the inclusion of data from the Southern States where the climate is regarded as relatively unfavourable (Stuart, 1928). The best yield recorded for individual states is the 5 tons or more in Maine, which has a very "North-west European" climate. The U.S. seed-rate, averaging 8.6 bushels, is, however, much lower than the U.K., so that the over-all yield of 92 bushels in 1915-1919 (*ibid.*) was over ten-fold.

As showing maximum possibilities it may be mentioned that in British official potato trials yields range between 10 and 18 tons per acre for the best varieties (13.2-17.3 for Kerr's Pink). The conditions given to the plants in these trials are extremely good. The ground, which is presumably in good heart to start with, receives up to 18 tons to the acre of farmyard manure plus "a concentrated potato fertilizer". Moreover the trials are "open to the criticism" that they deal "only with super grades, which cannot be considered as representative of commercial stocks" (Bryan, 1937).

Very few details of potato yields in African areas can be gleaned from literature. Most of the data in the following paragraphs are unpublished and kindly communicated by departments and the grower named.

Kenya.—Many trials at Kabete have been reported in Annual Reports of the Department of Agriculture from 1909 onwards, but areas and conditions are not specified. A noteworthy feature is the great variation in yield between varieties and between seasons. A few of the yields recorded on plots are high: 10.6 tons for Epicure in 1913, 11.5 for Scottish Triumph in 1909, 12.2 for Dalmeny Beauty in 1911. Recent trials have given (calculated) yields of 2-7 tons to the acre, with this range of variation even for a single variety (Majestic). "Over a number of years Kerr's Pink have averaged about 4 tons to the acre", and this variety has been the most popular in Kenya until 1943, when Late Blight compelled some change. It is unfortunate that all the available records of official trials are from Kabete and Nyeri, places at the lower edge of the Kenya potato-growing areas and climatically not nearly the best. It has been stated (Jex-Blake, 1939) that "under garden conditions 10 tons to the acre may be expected", i.e. with the seed-rate he specifies, a 16-fold yield. I can say from personal experience that this rate of yield can be surpassed in an East African garden. Moreover, commercial yields of over 8 tons per acre are obtained by some careful growers in the Thomson's Falls area (J. K. Hill *in litt.*). More data from Kenya growers are desirable but have proved difficult to obtain.

Tanganyika

Locality	Variety	Tons per acre
Kilimanjaro ..	"Native-type" ..	3
Iheme (near Iringa)	Great Scot ..	3
Usambara	Kerr's Pink ..	4
Usambara	Arran Chief ..	8
Uluguru	Arran Chief ..	Up to 6½
Uluguru	Abundance (old seed)	Up to 5

The above yields are from trials, except on Kilimanjaro. The Iheme trials were on poor sandy soil dressed with farmyard manure at the rate of 10 tons to the acre, spacing 3 ft. by 1 ft. The Usambara plots had been "heavily dressed" with farmyard manure.

Belgian Congo.—The native growers in Marungu, *c.* 6,500 ft., on the west side of

Lake Tanganyika in about the same latitude as Iheme, get 2-4 tons an acre (Theuwissen, 1934).

Northern Rhodesia.—Average yield 2½ tons per acre: "better growers expect 4 tons".

Southern Rhodesia. (16-22°S.).—Average for whole colony no better than 1.4 tons per acre, but good commercial growers get 6.7-7.8 tons, exceptionally up to 13.4 (Timson, 1931) or even more; and on 3 acres under the Department of Agriculture 12.5 tons per acre were obtained (J. C. Hopkins *in litt.*).

Union of South Africa (22-34°S.).—Over-all average was 1½ tons in 1911; "under intelligent management and in favourable localities 4½ tons" (Leppan and Bosman, 1923). In 1938/39 the over-all average was about 2¼ tons per acre. This naturally masks a wide variation. In fact "10 tons per acre have been obtained on occasion from winter production, which at any rate demonstrates that potential yields under short days are good, even if they do not reach the high marks of summer production" (Department of Agriculture *in litt.*, 1943).

For comparison with the foregoing it is interesting to give yields obtained elsewhere at latitudes lower than the U.K.:—

Australia.—Over-all average, 2.6 tons per acre, varying from 1.6 in Queensland (at ca. 22°S.—Straughan, 1938) up to about 3½ tons in Tasmania (41-44°S.), 3.83 in South Australia (ca. 35°S.) and 4.45 in West Australia (Bald, 1941).

India.—At Cawnpore, 26°N., sown November, dug February, 7 tons per acre (Wright, 1877).

Mauritius.—20°S. (computed) yield of potatoes carefully tended, up to 6 tons per acre; if dependent entirely on rain, 3-4 tons (Coombes, 1940).

Hawaii.—20°N. In trials of 11 varieties, 7 gave over 6 tons to the acre, 3 over 7½ tons and the best over 8 (Hawaii, 1939).

Java.—6-8°S., only ½-1 ton per acre obtained by native growers, while European growers, using varieties from Holland and Germany, "aimed at 1½-2½ tons" (Paravicini, 1923). These figures seem excessively low and they have doubtless since been improved now that local European growers are making their own selections (Buyze, 1929). Papers on Java potato production unaccountably omit yield data but 8 tons per acre on a small-holding seems indicated by Dijkstra (1940).

General.—"Five tons per acre in the tropics may be considered a good return" (Macmillan, 1935). This, on the seed rate specified, would be over 12-fold.

Obviously the foregoing figures, of such varied provenance, can only be used as a basis of argument with great caution. Spacing is referred to later. At the present stage of our discussion it suffices to observe that some astonishingly high yields have been recorded at low latitudes as well as some astonishingly low ones, and to point out that in attempting to evaluate them in connexion with climatic factors it is necessary to bear in mind others, which are, for the most part, under control of the grower. It is also instructive to note that the low yield in Tasmania can hardly be imputed to short-day in any degree because the latitude is practically the same as that of Chiloe, the hypothetical source of such long-day adaptation as the potato plant possesses.

There can be no doubt that the yields obtained by most non-European growers at low latitudes suffer from poor seed, poor cultivation, inattention to manuring, if not also premature digging, e.g. to forestall praedial larceny (Paravicini, 1923). Often "potatoes are not so much grown as allowed to grow" as has been remarked of an East African area (R. W. Collett *in litt.*). Some of the African potato plots survive year after year by "self-setts".

The yields of European growers at low latitudes are not unaffected by some of these factors. What proportion of the tropical potato crops receive the "only moderate dressings (12-15 tons) of farmyard manure . . . supplemented by generous applications of artificials", which are the standard in Britain (Wallace, 1941)? As affecting their potato yields the South African Department of Agriculture attributes great importance to their soils being "on the whole so much poorer" than in Britain. But even in Britain no soils are regarded as too good for the crop: it is recognized that "good yields cannot be obtained from shallow soils nor from soils that are not highly fertile" (Wallace, 1941). In Southern Rhodesia, as in South Africa, the low yields are recognized by the Department to be "very largely due to insufficient applications of manure and fertilizer as well as to the use of degenerate seed".

"Degeneration" seems as a rule to be due to accumulation of virus diseases. These depend in part on the prevalence of aphid vectors, which are greatly affected by climate. It has been shown conclusively in the U.K. (*see* especially Staniland, 1943; Whitehead, 1943), that damp, windy places, which are bad for

aphids, are precisely those in which healthy stocks of "seed" potatoes can be best maintained. There is no doubt that aphid-borne virus-diseases are a factor in depressing potato yields in parts of East Africa, but the whole relationship between vector and climate needs to be worked out anew here. Meanwhile it may be noted that hot, dry, bright climates tend to prevent the visible symptoms of virus disease developing; while plants showing no such symptoms may nevertheless have their yields reduced by as much as 12 per cent by virus (16*th Ann. Rep. Coun. Sci. Indust. Res. Australia,* 1943).

Apart from any question of its healthiness, the seed used by many tropical growers is not adapted to produce the best yields. Even in Australia it is "still the method used by a large proportion of growers" to choose those tubers "unfit for sale because of small size or blemishes" (Bald, 1941). The economically-minded peasant, when he does re-seed, naturally inclines to use "chats"; and Salaman (1926) has shown that yield prospects are reduced by the use of setts averaging less than 2½ oz. in weight. From the experiment he quotes, setts of under ½ oz. can be expected to give hardly more than two-thirds as much crop as setts weighing 1½ oz., though there is little to be gained by increasing the weight further. Brandreth (1935) and Brandreth and Bryan (1937) have since also shown that seed pieces, whole or cut, weighing 2-3 oz. gave a better yield than smaller ones.* Against this, however, it has recently been reported from Russia that "small pieces of tuber weighing about ½ oz. and containing one of the upper eyes . . . yield as well as whole tubers and their produce is less subject to disease" (*Nature* 151, 77, 1943). Experiments with this method are proceeding at Kew.

Finally it is worth pointing out that the averages of the commercial yields in most low-latitude countries are depressed by the inclusion of yields obtained in areas that by reason of poor soil or unfavourable climate are definitely marginal. For instance, in Australia drought is a common enemy of yield (Bald, 1941). And in most tropical areas there is a tendency to push potato cultivation into areas that are really too hot. The element of "marginal" statistics certainly operates to depress the average yield of the U.S.A. in the same way; but it can hardly be of importance in those countries, the U.K., Belgium and the Netherlands, which we take as the standard of comparison.

(To be continued)

* J. Hawkins notes (*in litt.*) that "the optimum size of a sett depends very much upon the number of eyes. One strong eye attached to a piece of sett (cut) measuring about ½ inch cubed, will, if planted carefully, produce a good average crop of large potatoes. A large sett, if bearing plenty of eyes, tends to produce a crop of many small "chats". The ideal average for most varieties is 2-3 oz., if intended to produce ware potatoes, but its eyes should be limited to 3 at the most, and this can be done only if sprouted before planting." This operation also shows up any tubers that are "blind" from disease and hence useless for planting.

VERMIN DESTRUCTION

The following are contributed by Mr. R. N. Savory, Kipkabus:—

HYENAS

A few years ago my farm (not large, only 730 acres) was overrun with hyenas. At last, one day, I sent boys out to locate them. They reported five near my house, each with six to eight half-grown pups, and they located the dens. I went to each den in turn, enlarged the entrance and built a large fire, which I kept burning until there was a large heap of glowing coals. These were then shovelled into the hole and the earth banked firmly over the top. The glowing coals soon exhausted the oxygen in the dens, and the hyenas could not come out because of the fire. I have not been troubled since.

RED MITE IN POULTRY

I have found that one gallon of power paraffin with about a half-teacupful of Kynoch Tick Oil makes an excellent mixture for these. It can be applied to the walls of the house with a brush or a hand spray, and will penetrate into the cracks. It needs to be applied once a month.

As regards item 1 the Vermin Control Officer, Game Department, Kenya, comments:—

Mr. Savory's method of hyena destruction is considered excellent as an alternative to poisoning and when sufficient labour is available. Before this method is started on care should, of course, be taken to see that spoor indications reveal the presence of hyenas in the holes.

In much the same way natives try to burn out porcupines, but their efforts frequently result in failure because of the slipshod, half-hearted manner in which the job is done.

OBSERVATIONS AND EXPERIMENTS ON FLOWERING AND POLLINATION OF THE TUNG TREE

By C. C. Webster, Tung Experimental Station, Department of Agriculture, Nyasaland

The work described in this paper was carried out in Nyasaland in 1939, 1941 and 1942, and comprised observations on the flowering habit, pollination and fruit setting of *Aleurites montana*, and experiments on the artificial crossing and selfing of high-yielding trees. Apart from making general notes on the flowering habit of this species, the main objects were, firstly, to study pollination both in a seedling plantation, containing a large proportion of predominantly male trees, and in a plantation of buddings in which there were very few males, and secondly, to raise a number of legitimate seedlings by the artificial crossing or selfing of high-yielding trees. In the latter experiments it was particularly necessary to find out if the high-yielding, predominantly female trees were self-fertile.

Flowering Habit

The species is normally monoecious, although occasionally trees are found which, at any rate in some seasons, produce only flowers of one sex. The male flowers, which are from an inch to an inch and a half in diameter, have five white petals and ten stamens in two whorls of five; they possess honey glands, and the pollen is somewhat heavy and sticky. The female flowers are somewhat larger and contain a trilocular ovary surmounted by three two-lobed stigmas. On first opening the flowers of both sexes are white, but later the base of the petals becomes tinged with red and a deeper red colour is also developed on the stamens. Occasional perfect or hermaphrodite flowers have been found.

The trees bloom at the end of the dormant season and the flowers, which emerge just after the first new leaves, are borne in paniculate cymes at the ends of twigs of the previous season's growth. Broadly speaking there are three types of flowering cluster, although intermediate forms are found to some extent:

(1) *Male clusters.*—These emerge simultaneously with the first new leaves and the individual flower buds can be seen forming a dense head as soon as the main terminal bud opens. When fully opened the inflorescence is large and much branched and commonly bears 200 or more male flowers. Quite often the flowers borne at the ends of the main branches of the cyme are female, and when this is so these flowers are always the first to open in the cluster, but none have yet been observed to set fruit.

(2) *Female clusters.*—These are borne at the end of a short leafy shoot of the new season's growth and do not emerge until this shoot has grown out several inches. The inflorescences are smaller and denser than the male clusters and contain, on an average, only about 20 flowers.

(3) *Clusters containing flowers of both sexes.*—The structure and mode of production of these clusters is as described for the female inflorescences. The female flowers are borne in the more central positions in the cyme and always open some time before the males; usually all the female flowers are over before the first male in the same cluster opens. The number of males varies from very few to as many as, or more than, the females, but usually there are less males than females.

The buds of individual male and female flowers are easily distinguishable before they open, the former being oval in shape and the latter larger and conical. The male clusters can also be recognized at an early stage from the fact that they are the only ones visible as soon as the terminal buds of the previous season's shoots open.

In a previous article in the *Journal* [1] reference was made to the fact that in a seedling plantation of this species the proportion of male and female blossom varies from tree to tree, and it was pointed out that although a certain number of trees are found which bear flowers of both sexes in approximately equal proportions, there is a general tendency for trees to be predominantly male or predominantly female. It was mentioned that in three plantations examined (two in Nyasaland and one in Burma) approximately 40 per cent of the trees were found to be predominantly male, and a similar figure, 45 per cent, was quoted from Indo-China [2]. More recent observations in Nyasaland have shown that the above statements require slight modification as it has been found that in the past two seasons some of the older heavier-bearing trees (now eleven years old) have borne a larger proportion of males than they did previously, and it is evident that on the basis of an actual count of the male and female flowers they could no longer be regarded as predominantly female, although

they have continued to give increasingly heavy crops. The variation in flowering habit in a seedling plantation may therefore be more correctly described as follows:—

(*a*) A proportion of the trees, usually from 40 to 50 per cent, are predominantly male and bear only a little fruit. These trees are readily picked out in a field at flowering time as nearly all their flowers are produced in the large male clusters described above and their bloom is therefore much more profuse and showy than that on the female trees. A small proportion of female flowers is also borne on these trees, either in central positions in the big male clusters, in which case they are the first flowers to open but set no fruit, or else in separate female or mixed clusters which are not usually opened until the peak of male blossom production is past. These trees will in future be referred to as "males", as although they actually bear a little female flower, they may for practical purposes be regarded as males since they produce a mass of male blossom and only a little fruit.

(*b*) The remaining 50 to 60 per cent of the trees bear an appreciably greater proportion of female flowers than the males described above, although it is probable that many of them are not actually predominantly female, especially if the plantation is over eight years old. The majority of their flowers are produced in female or mixed clusters although a few big male clusters may be found. Normally the first flowers to open are females, and males do not follow until the majority of the female blossom is over. There is thus generally a female phase followed by a male phase, although in many trees these overlap to some extent. These trees will in future be referred to as "bearing trees", as they produce the vast majority of the fruit in the plantation, but cannot rightly be called "female" trees for reasons already explained.

A certain number of trees are found which are intermediate between (*a*) and (*b*) but these are relatively few in number, and the division into male and bearing trees is well marked. It is improbable, however, that the proportion of male and female blossom is fixed and permanent on any tree. Some seasonal variation in the amount of male flower produced on bearing trees has already been noted, but, although this variation from year to year is quite marked on certain trees, no case has yet been observed in which a tree was "male" one year and "bearing" the next, or vice versa. It has been suggested by workers in Indo-China that the male trees may undergo a change of sex as they grow older, and that the proportion of males in a plantation is influenced by soil and climate [2]. No evidence in support of the latter suggestion has so far been obtained in Nyasaland, nor has any *marked* change of sex occurred in the male trees, now eleven years old, which have been under observation at the Zomba Experimental Station. In the last three years some of these trees have borne more female flowers, and set more fruit than formerly, but this increase in bearing has been small, and the trees are still for all practical purposes males.

Pollination

As the blossoming period of any tree tends to be divided into male and female phases it follows that the trees must be mainly cross-pollinated, although selfing of some of the flowers is possible on many trees in which the two phases overlap. From the structure of the flowers and the fact that the pollen is relatively heavy and sticky, it seems evident that insects are mainly responsible for pollination. Fairly strong winds often occur at blossom time and it is probable that some pollen is then blown about but it is thought that wind plays a minor part. A considerable variety of insects visit the flowers and it is not known which are mainly responsible for pollination. It may be noted that bees cannot be the main agents because although they visit the male flowers in very large numbers, they are only occasionally found on the females.

In 1941 and 1942 fairly detailed observations were made on flowering and fruit-setting with two main objects in view:—

(1) To determine if natural pollination is adequate in a seedling plantation, containing 40 to 50 per cent of male trees, or if some potentially high-yielding trees fail to set a good crop because they flower either before or after the majority of the male trees.

(2) To determine if natural pollination is adequate in a plantation where most of the males have been topworked, leaving only five males per 100 trees.

In 1941 a plot of 218 trees containing 53 per cent of males was selected in a four-year-old seedling plantation at Namingomba Estate, and all trees were carefully examined every three or four days throughout the blossom period in order to obtain a record of the type of flower open on each tree on each occasion. It was intended to keep similar records in a budded plantation during the same season but this was not possible in 1941. In 1942, how-

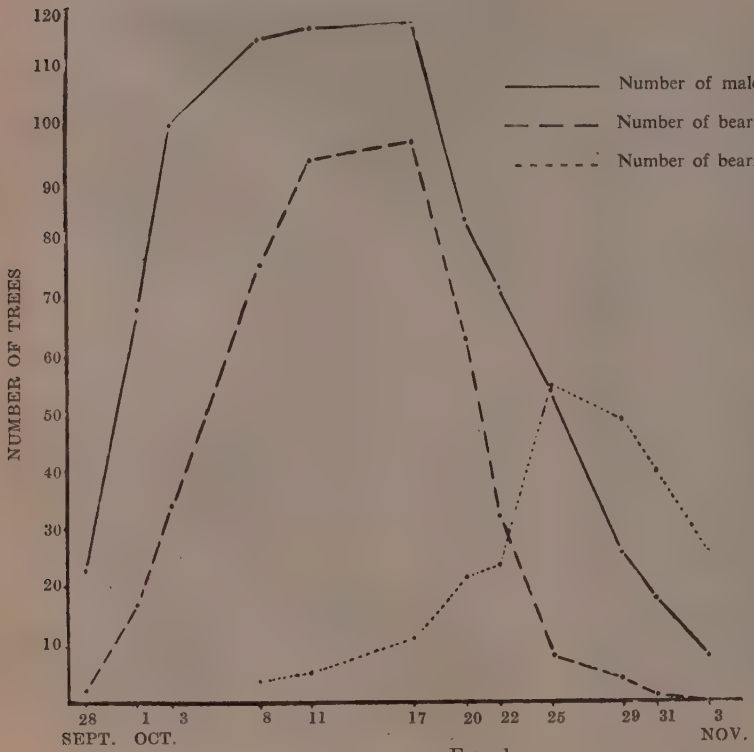

Number of male trees with open male flowers.
Number of bearing trees with open female flowers.
Number of bearing trees with open male flowers.
NUMBER OF TREES
120
110
100
90
80
70
60
50
40
30
20
10
28 SEPT.
1
3
8
11
17
20
22
25
29
31
3 NOV.
OCT.

FIG. 1

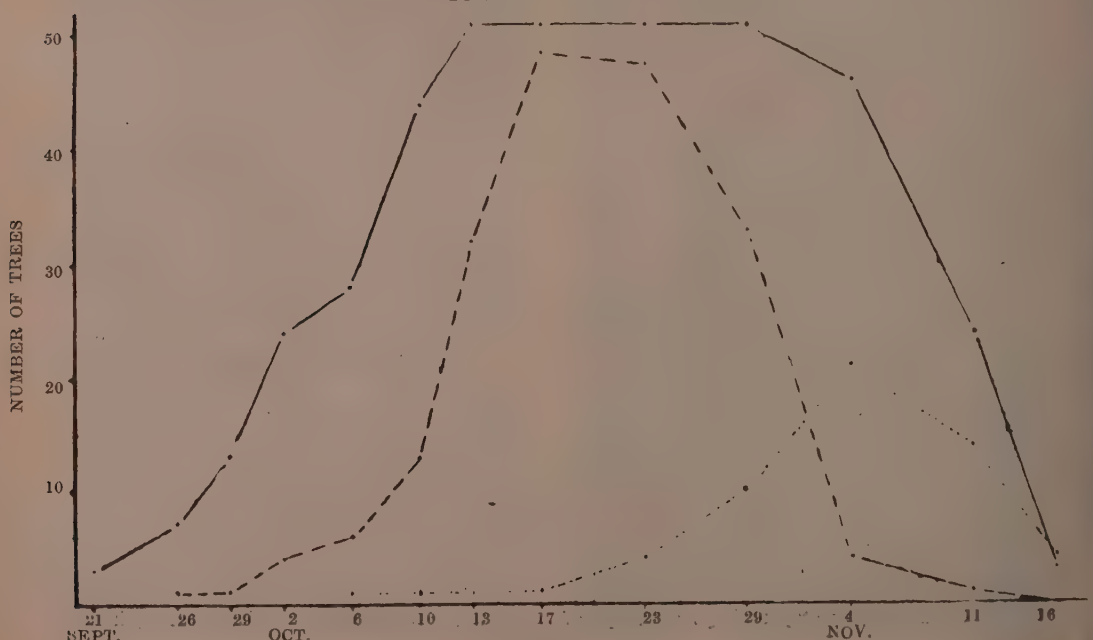

NUMBER OF TREES
50
40
30
20
10
21 SEPT.
26
29
2 OCT.
6
10
13
17
23
29
4 NOV.
11
16

FIG. 2

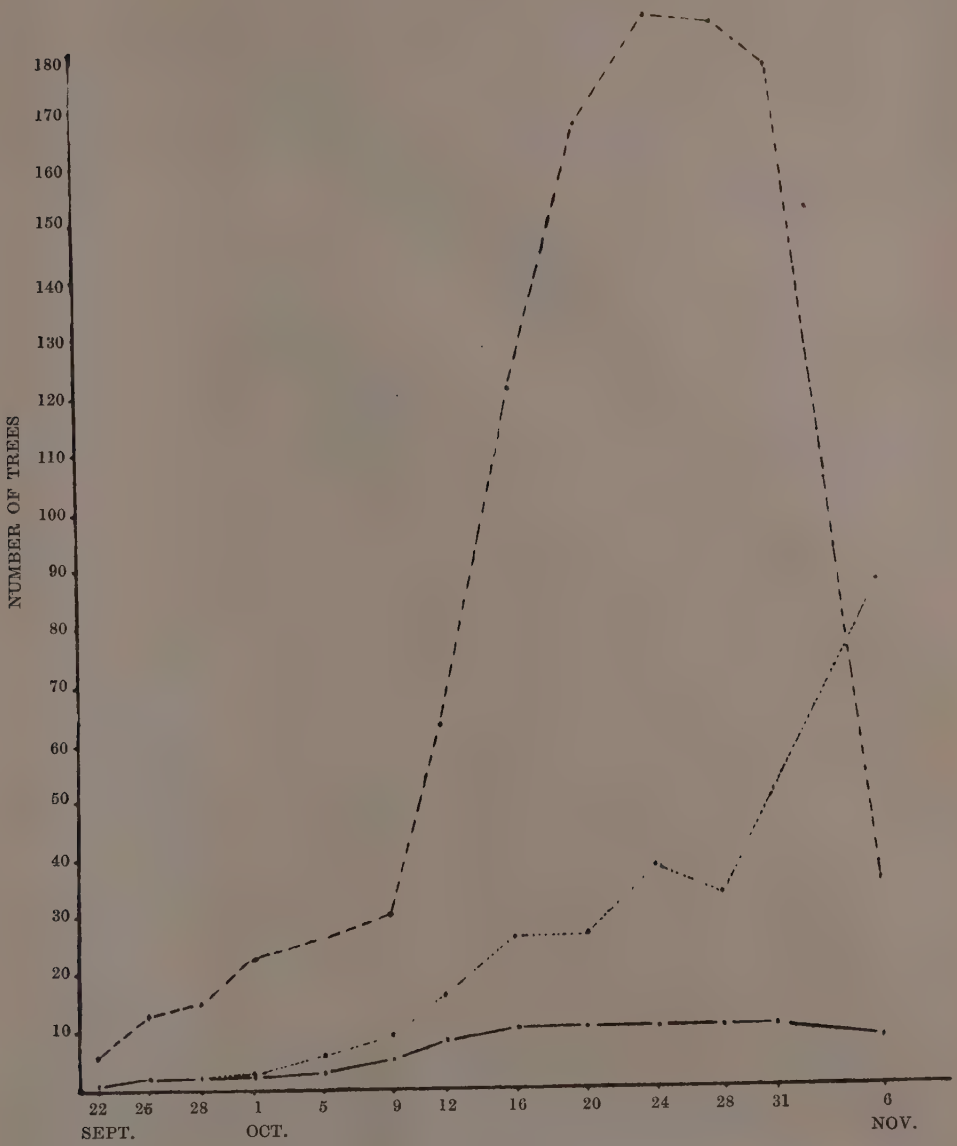


FIG. 3

——— Number of male trees with open male flowers.

— — — Number of bearing trees with open female flowers.

- - - - - - Number of bearing trees with open male flowers.

ever, such observations were made on a plot of 197 trees aged six years in a budded field at Msiwika Estate and on another plot of 100 trees in a seedling plantation five years old at Namitembo Estate. The Msiwika plot contained 10 males (5 per cent) and 187 bearing trees, some of which were seedlings and others males which had been topworked with scions from bearing trees two years previously and were flowering for the first time. The plot was situated in a field of about 15 acres throughout which only 5 per cent of unworked males had been allowed to remain. The Namitembo plot contained 51 males (51 per cent). The figures obtained by summarizing these records are shown in Tables 1, 2 and 3 and represented graphically in Figures 1, 2 and 3.

Further information on pollination was sought in the following manner. In each plot 10 flower-clusters were tagged on each of a number of bearing trees, all the clusters being at approximately the same stage of development when tagged, i.e. with the earliest flowers just opening. On each tree five of the clusters were pollinated artificially every day for three or four days, and five were left to receive natural pollination only. When they were first labelled a count was made of the number of female flowers in each cluster and at the same time any male flower-buds were removed. Six weeks later the number of fruit set in each cluster was counted. In the Namingomba plot 170 clusters on 17 trees were dealt with in this manner, at Namitembo 160 clusters, and at Msiwika 200 clusters. Table 4 shows the percentage of female flowers which set fruit in each plot. As a matter of interest the average number of female flowers per cluster and the average number of fruit set per cluster are also shown. The figures for fruit-setting obtained six weeks after labelling actually represent the set of fruit which is carried to maturity, as subsequent counts showed that no subsequent shedding occurred.

TABLE 1
OBSERVATIONS IN NAMINGOMBA SEEDLING PLOT, 1941

DATE	28th Sept.	1st Oct.	3rd Oct.	8th Oct.	11th Oct.	17th Oct.	20th Oct.	22nd Oct.	25th Oct.	29th Oct.	31st Oct.	3rd Nov.
Number of male trees with male flowers open ..	23	68	100	115	117	118	84	72	54	26	18	8
Number of bearing trees with female flowers open ..	2	17	34	76	94	97	63	32	8	4	1	—
Number of bearing trees with male flowers open ..	—	—	—	4	5	11	22	25	55	49	40	26

TABLE 2
OBSERVATIONS IN NAMITEMBO SEEDLING PLOT, 1942

DATE	11th Sept.	16th Sept.	21st Sept.	26th Sept.	29th Sept.	2nd Oct.	6th Oct.	10th Oct.	13th Oct.	17th Oct.	23rd Oct.	29th Oct.	4th Nov.	11th Nov.	16th Nov.
Number of male trees with male flowers open	1	2	3	7	13	24	28	44	51	51	51	51	46	24	6
Number of bearing trees with female flowers open	—	—	—	1	1	4	6	13	32	47	46	33	4	1	—
Number of bearing trees with male flowers open	—	—	—	—	—	—	1	1	1	1	4	10	21	14	4

TABLE 3
OBSERVATIONS IN MSIWIKA BUDDED PLOT, 1942

DATE	22nd Sept.	25th Sept.	28th Sept.	1st Oct.	5th Oct.	9th Oct.	12th Oct.	16th Oct.	20th Oct.	24th Oct.	28th Oct.	31st Oct.	6th Nov.
Number of male trees with male flowers open	1	2	2	2	3	5	8	10	10	10	10	10	8
Number of bearing trees with female flowers open ..	6	13	15	23	26	30	63	121	167	185	184	177	35
Number of bearing trees with male flowers open ..	—	2	2	3	6	9	16	26	26	38	33	51	87

TABLE 4

FRUIT SETTING ON INFLORESCENCES RECEIVING (*a*) NATURAL POLLINATION ONLY, (*b*) NATURAL PLUS ARTIFICIAL POLLINATION

Number of Percentage	Natural Pollination only		Natural plus artificial pollination		All clusters	
	Number of of clusters recorded	Percentage of flowers setting fruit	Number of clusters recorded	Percentage of flowers setting fruit	Average number of female flowers per cluster	Average number of fruit set per cluster
Namingomba, 1941 ..	85	14·5	85	16·1	20·2	3·1
Namitembo, 1942 ..	80	21·7	80	20·4	18·9	3·8
Msiwika, 1942	100	18·6	100	18·0	20·3	3·7

It will be seen that the graphs for the two seedling plots (Figs. 1 and 2) are very similar, particularly if allowance is made for the fact that owing to different weather conditions the trees throughout the district flowered over a longer period in 1942 than in 1941. In both plots the earliest trees to come into flower were males, and throughout the blossom season there were more male trees with open male flowers than there were bearing trees with open female flowers. The figures, of course, take no account of the amount of blossom open on any given tree; thus a male tree with only a few clusters open appears as of the same value as one in full blossom. But as the same applies with regard to the amount of female flower open on the bearing trees, and as male trees always bear vastly more flowers than bearing trees, it is considered that the figures do actually illustrate the fact that there was at all times an abundance of pollen in the plots. The records also showed that the average period during which a male tree carried open male flowers was from a week to a fortnight longer than that during which a bearing tree carried open female flowers. The graphs show that further pollen was available in the latter part of the flowering season from male flowers which were produced on the majority of bearing trees after their main flush of female blossom was over. No bearing trees were found which failed to set a good crop because they opened their female flowers at a time when there was little or no pollen about. Nor were they found in three other seedling plots, totalling 870 trees, in which less detailed observations were made. It therefore seems that if such trees exist at all there can only be very few of them.

Table 4 shows the mean percentage of female flowers which set fruit in the clusters which received natural pollination only. There is no significant difference between the two figures for either plot and no improvement in fruit setting resulted from the extra pollen provided artificially. It may be suggested that artificial pollination might perhaps reduce the set of fruit, as a result of mechanical damage to the stigmas or some similar cause, but in view of the successful results obtained with the same method of pollination in the breeding experiments described later it is thought that this possibility can be ruled out.

The results of all these observations therefore indicate that pollination is adequately provided for in seedling plantations. As such plantations normally contain 40 to 50 per cent of male trees, this was to be expected, and the records were mainly made for comparison with those from the budded plot.

The question of pollination in budded plantations is an important one as it is expected that considerable areas of buddings will be planted in the near future and it is essential to know what provision, if any, should be made to ensure adequate pollen in fields where all the scions will come from bearing trees which produce a relatively small proportion of male flowers. In the past two or three years topworking of male trees in established plantations aged three or four years has been carried out fairly extensively by budding on to the main branches of the males with scions from good bearing trees. As described elsewhere [3] the earliest results have shown that this method has been successful in converting the male trees into bearers which produce an abundance of female flowers and set a crop of fruit. It was suggested to planters that in such topworked fields five males should be allowed to remain in every 100 trees. This had been done in the Msiwika plot already mentioned, and the ob-

servations were therefore made to try and find out if the pollen from the 5 per cent of male trees, together with that from the bearing trees, was sufficient to give a normal set of fruit.

The graphs (Figure 3) show that although there was naturally a much greater number of bearing trees with open female flowers at all times, the ten male trees nevertheless provided some pollen throughout the flowering period and this was considerably augmented by pollen produced on the majority of the bearing trees, particularly in the latter part of the season, although some bearing trees also produced male flowers quite early. Actually 57 per cent of the bearing trees opened male flowers in the period during which records were kept. It is probable that more of them did so later, but the pollen from them would be of no value as female flowering was then over. There was again no significant difference in the percentage of flowers which set fruit in the clusters which received natural and artificial pollination and in those which received natural pollination only. It will also be noticed that the percentage set was comparable with that obtained in the seedling plots. It therefore appears that fruit setting was not appreciably limited by lack of pollen even although the plot only contained 5 per cent of male trees. The 200 clusters in this experiment were in flower from the 22nd to the 31st October. Further records were obtained from earlier clusters, when there was much less pollen available from bearing trees, by tagging 50 clusters on the 5th October and 50 on the 13th October. These gave sets of 22.5 per cent and 20.5 per cent respectively, and it therefore seems that fruit setting was satisfactory throughout the season.

Further information was obtained from several plots of budded trees which flowered for the first time in 1942. All these trees had been raised by budding one-year seedling stocks at the base of the stem in September and October, 1940. One such plot consisted of a block of 60 trees of clone G14 arranged in five rows stretching across the middle of a six-acre field, the remainder of which had been budded with other clones. The clone G14 was found to flower very early and was covered with female blossom before any of the other trees in the field had begun to flower. As no males were opened on any of the G14 trees until much later, the nearest open male flowers were on two small male trees about 400 yards away in an adjoining field. There were also a few other early-flowering male trees in blossom at a greater distance, but the total amount of pollen was certainly much less than that which would have been provided if 5 per cent of males had been included in the monoclone block. Thirty flower clusters were labelled on six trees and counts made of the number of female flowers and number of fruit set in the manner described above. The percentage of flowers setting fruit was 22.5, which it will be seen is well up to the set obtained in the seedling plantations. As a matter of fact, the cluster counts were really unnecessary, because six weeks after flowering it could be seen at a glance that all the trees of this clone were laden with fruit, and it was therefore obvious that fruit setting had not been appreciably reduced by lack of pollen.

A second plot contained 189 buddings belonging to eight clones and was situated three-quarters of a mile away from any other trees in flower. All these trees were predominantly male flowers, and in three clones the males were opened at about the same time as the earliest female flowers, with the result that some pollen was available in the plot throughout the blossoming period. All the clones set a crop of fruit and three of them, including the earliest flowering clone, bore a very heavy crop. As no male trees were present it is clear that the pollen came only from male flowers produced on the buddings. In this and other plots observations were made on the flowers of just over 1,000 budded trees belonging to 14 clones, and it was found that some trees of all clones, produced male flowers, although only the three clones already mentioned opened males at the beginning of their flowering period.

It is thought that the evidence obtained as a result of all the above observations justifies the conclusion that the provision of 5 per cent of male trees in a budding plantation will ensure satisfactory pollination, provided that some of the male trees have an early flowering habit. The inclusion of some early-flowering males is obviously desirable in view of the fact that the majority of the male flowers produced on bearing trees are not opened until the latter part of the flowering season. It would also be unwise at present to plant up large monoclone blocks—several clones should be used in any one plantation. It may be possible to do with less than 5 per cent of male trees, or even with none at all, but this will require further investigation, particularly as the present results refer only to the buddings in their first flowering season, and their flowering habit may change to some extent as they grow older.

Artificial Crossing and Selfing

Small-scale experiments on artificial crossing and selfing of high yielders were carried out in 1941 and 1942 for the following purposes:—

(1) To work out a suitable technique for the work.

(2) To determine if self-fertility is general amongst high-yielding trees.

(3) To raise a small number of legitimate seedling progenies from high-yielding trees with a view to obtaining improved planting material from the best seedlings by vegetative propagation in a few years' time.

(4) To raise a small number of *A. montana* x *A. fordii* hybrids.

The usual methods employed for this kind of work were found to be quite satisfactory. Cellophane bags were used to enclose the flower clusters and as the bags were rather small it was found necessary to reduce the size of the inflorescence by pruning off some of its branches, so that only four to eight flowers were pollinated in each bag. Unopened female flowers were bagged one to two days before pollinating and the male flowers on the pollen parent were also bagged. Pollination was effected by very gently brushing the freshly dehisced anthers against the stigmas, and the bags were kept on the female cluster for 14 days after pollination. All the female flowers in one bag were pollinated with the same pollen parent. Results are shown in Table 5, the percentage of successful pollinations being based on fruit counts made ten weeks after pollinating.

The percentage of flowers setting fruit is in all cases higher than that obtained in the pollination experiments in the budded and seedling plots which have already been described. This is presumably due to the reduction in the number of flowers per cluster which was made before bagging. In both seasons a number of clusters were bagged but left unpollinated, a total of 123 flowers on eight trees for the two years. None of these set any fruit.

A satisfactory set of fruit was obtained as a result of self-pollination on all the eleven trees on which it was tried and it therefore seems evident that self-fertility is fairly general in this species. Selfing, however, is not possible on all bearing trees as by no means all of them produce open flowers of both sexes at the same time, and as the female flowers are almost invariably produced before the males it is not possible to remove and store pollen for later use. Of the 423 bearing trees in the plots at Namingomba, Namitembo and Msiwika, only 22 per cent bore open flowers of both sexes simultaneously. With older trees a higher proportion would probably be found, but selfing is certainly not possible on all high-yielding trees. With some individuals, however, although selfing would not be possible on the mother tree itself, the same result could be achieved by crossing between members of a clone of buddings derived from it.

Table 5

Season	*Montana* × *fordii*			*Montana* × *montana*			*Montana* selfed		
	Number of mother trees	Number of crosses	Percentage of crosses successful	Number of mother trees	Number of crosses	Percentage of crosses successful	Number of mother trees	Number of crosses	Percentage of crosses successful
			Per cent			*Per cent*			*Per cent*
1941 ..	1	28	28·6	2	185	37·3	1	42	38·1
1942 ..	3	116	26·7	3	248	52·8	10	293	43·3

REFERENCES

[1] Webster, C. C.—"A Note on the Yield of Tung Trees in Nyasaland"; *E. African Agric. J.* 6, 160, Jan. 1941.

[2] Anon.—"Tung Oil in Indo-China". *Bull. Imperial Institute*, 37, 32, 1939.

[3] Webster, C. C.—"Topworking *Aleurites montana*; the results of some preliminary experiments"; *Nyasaland Agric. Quart. J.* 2, 10, April, 1942.

(*Received for publication on 20th June*, 1943)

Africa is one of the ultimate tests of the white man's "civilizing" power, a challenge to put into long-range and humane synthesis the terrible resources of his will and science.

Dr. Isaiah Bowman in *Focus on Africa.*

Soil conservation . . . . is the mark of a virile people who put science to work in the common things of life for its own survival.

Dr. W. C. Lowdermilk.

COMPOSITION AND NUTRITIVE VALUE OF PULP AND SEEDS IN THE FRUIT OF THE BAOBAB

By M. H. French, M.A., Ph.D., Dip. Agric. (Cantab.), Veterinary Laboratory, Mpwapwa, Tanganyika Territory

The baobab tree (*Adansonia digitata*) is found growing over a large proportion of the African continent, and is a characteristic feature of the landscape of much of this Territory. The fruit of the baobab varies somewhat in shape but is usually oblong, or marrow-shaped, and up to a foot in length and about four inches in diameter.

It is indehiscent and its outer woody shell is filled at maturity with a dry pulp in which are embedded many seeds the size of marbles. Published analyses of the seeds show that, though they have a rather high fibre content, they are fairly rich in ether extractives and crude protein. Greene (*Bot. Gaz.* 94, No. 1, Sept. 1932) says that "the seeds, so far as analysis shows, should make a very good stock feed when ground".*

Inquiry amongst local natives showed that, in years when the groundnut crop failed, these seeds were collected and cooked in the same way as groundnuts. They are, however, regarded only as an inferior substitute for groundnuts. Inquiries concerning the use of baobab seeds and pulp as stock foods elicited the information that the herdsmen do not knock down nor break open the fruits for their animals but that, when the outer woody shell has become weathered and broken, sheep, goats, cattle and a number of wild animals eat both the pulp and the seeds.

It was considered worth while to investigate more fully the feeding value of the seeds and pulp because, owing to the wide distribution of this tree, they might form a valuable addition to the diet of stock in the dry season when the grazings are nearly eaten out.

Fruits were collected from the trees on the Mpwapwa farm by Mr. H. Winship, who estimated that the cost of collecting and carting the fruits and the subsequent extraction of the seeds and pulp amounted to 4 cents per pound of seeds and pulp mixture.

The composition of the mixed pulp and seeds is shown in Table I, together with figures computed from the separate analyses of pulp and seeds by Greene, who estimates that the ratio of pulp to seed is 3:8. The mixture of seeds and pulp was found to contain 89 per cent dry matter.

TABLE 1

COMPOSITION OF THE MIXED PULP AND SEEDS FROM BAOBAB FRUITS

(Per 100 parts dry matter)

	Mpwapwa Sample	Greene's American Samples
Crude protein	11·18	10·93
Ether extract	7·84	5·46
N-free extract	50·01	55·85
Crude fibre	26·35	22·91
Total ash	4·62	4·85
SiO_2	0·10	—
SiO_2-free ash	4·52	—
Lime	0·438	—
Phosphate	1·227	—
Potash	1·535	—
Soda	0·282	—
Chlorine	0·264	—

The figures for the crude protein and ash contents agree very closely for these two sets of analyses, but the Mpwapwa sample was more fibrous and less rich in N-free extractives. The local sample was also richer in ether extractives than the American. It is interesting to note that East African seeds examined by the Imperial Institute (*Bull. Imp. Inst.* 11, 584, 1913), and Western African seeds reported upon by McCullock (*Rpt. Med. Health Serv.* Nigeria, 1932, p. 118) both contained much more ether-soluble matter than found by Greene. The mineral matter of the seeds and pulp mixture is rich in phosphate and potash.

The work of Greene and of Pelley indicate that a high proportion of the pulp is soluble in water. It also has an acid taste which these workers attribute to free citric acid (3-4 per cent) and to traces of malic acid and acids of the pectic type.

The seed possesses a hard coat, and though stock eat the seeds whole in the normal way, it would probably pay to crush or soak them before feeding. In the following digestion trial, so as to make the trial as comparable as possible with existing conditions of feeding, the seeds were not crushed.

Adult male native sheep were used for the digestion trials and the mixture of seeds and pulp was fed with a basal ration of chaffed hay of known digestibility. It was found that consumption of the seeds and pulp by the sheep was erratic, and several animals were

* Greene was working with American material, which must have been obtained from introduced trees. The genus *Adansonia* is naturally confined to Africa.—*Ed.*

tried before a pair were found who could be relied upon to eat completely every day the seeds and pulp when they formed one-fifth of the total ration. No digestive disturbances were observed. Table II sets out the average digestibility coefficients obtained with two sheep.

TABLE 2

AVERAGE DIGESTIBILITY CO-EFFICIENTS

	Per cent
Dry matter ..	54·98
Organic matter ..	54·96
Crude protein ..	48·36
Ether extract ..	88·38
N-free extract ..	61·96
Crude fibre ..	34·53
Soluble ash ..	55·18

The agreement between the results from the two sheep was not so close as is normally expected: the coefficients differed considerably for the crude fibre fraction. This is probably due to the woody nature of the fibrous strands in the pulp and to the hard fibrous coat of the seeds. Had the latter been crushed it is probable that closer agreement would have been recorded.

The ether extractives were highly digested, the fibre poorly, whilst the crude protein was not well utilized. The figure of 54.96 per cent for the total organic matter digestibility indicates that this mixture of seeds and pulp does not fall in the concentrate class of feeding stuffs.

In Table III the digestible nutrients and the starch equivalent values have been calculated.

TABLE 3

DIGESTIBLE NUTRIENTS AND STARCH EQUIVALENT VALUES OF THE SEEDS AND PULP FROM BAOBAB FRUITS
(Per 100 parts SiO2-free dry matter)

Digestible crude protein	5·41
,, ether extract	6·93
,, N-free extract	30·99
,, crude fibre	9·10
,, organic matter	52·43
Starch equivalent	44·58
Nutritive ratio	1:10

These figures indicate that the pulp and seeds of baobab fruits contain as much digestible protein as good local hays but a higher starch equivalent. They equal wheat bran in energy value but contain only half its quantity of digestible protein. Their feeding value, in fact, does not compare closely with any normal feeding stuff though they may perhaps be compared most closely with the pods of various other trees, such as *Acacia albida* or *Dichrostachys glomerata* (French—*An. Rpt. Dept. Vety. Sci.* Tanganyika Territory, 1932, p. 42, and 1934, page 79).

The important point is, however, that they are superior in feeding value to the grazings existent in the second half of the dry season, and for this reason they could form a valuable adjunct to the diets of stock at that time.

After the initial experiment it was decided to get further information regarding the palatability of the baobab material to stock because, as mentioned earlier, it is not eaten regularly by sheep if it forms one-fifth of the total ration. The pulp and seeds were then fed to another group of native and Black-headed Persian sheep which were receiving a concentrate mixture daily. These sheep would not eat the pulp and seeds and took only occasional mouthfuls. Well-fed Zebu bulls were found to eat the mixture of pulp and seeds in small quantities, but would not consume a regular quantity. Grade cows receiving other concentrates would not touch the mixture. Donkeys ate small quantities but not regularly. One horse, however, seemed to like them very much. They were greatly relished by Large White pigs and the local natives say that wild pigs will crack open somewhat weathered fruits and eat the contents.

It is obvious that the baobab fruits are not going to enter largely into the diets of native-owned stock but, nevertheless, they are eaten in small amounts. Larger quantities of the pulp and seeds would probably be eaten if the native herdsmen, when resting from the heat of the day, would open the fruits. Greater familiarity with this foodstuff would lead to greater consumption I am sure, because the sheep used in the digestion trials consumed a small quantity daily for five weeks and never left any residues. The above palatability tests, like all tests involving the introduction of fresh foods suffer from the drawback that stock will often not eat a strange food when they first meet it, though they may later develop a decided liking for it. The great liking for the pulp and seeds shown by pigs is of particular interest.

Summary.—The pulp and seeds of baobab fruits have a feeding value similar to that of other local tree pods. It is not, however, eaten in large quantities and cannot form a large part of the stock diets. The consumption of only small quantities is to be encouraged in the second half of the dry season because the feeding value of the pulp and seeds mixture is then superior to that of the grazings. Pigs show a marked liking for this mixture of pulp and seeds. The seeds possess a hard coat and the feeding value of the mixture would probably be increased by crushing the seeds.

(*Received for publication on 9th June*, 1943)

SOIL EROSION AROUND BUILDINGS, AND ITS PREVENTION

By G. B. Masefield, M.A., A.I.C.T.A., Soil Conservation Officer, Buganda Province, Uganda

Soil erosion caused by run-off from house compounds and from roofs is a major problem in the densely populated areas of Buganda round Kampala, which are often referred to as the "home counties". In these areas a very ordinary population-rate is about 100 families to the square mile. This means that there is one house compound in every 6½ acres, and when it is considered that a single compound can initiate two fair-sized gullies, the potentialities for erosion are seen. Experience over the last few years has, however, taught us various ways of mitigating this menace, many of which have been widely put into practice; and it is thought that they may be of sufficient interest to justify description in this article.

Another aspect of the same problem is the erosion caused at isolated points by large buildings and compounds, built by Europeans or developed under European influence. This category includes mission buildings and schools, Government plots of various kinds, and European and Asiatic houses in the urban area of Kampala and elsewhere. If the erosion from Africans' compounds is more insidious and widespread, that from European buildings is often more striking and may lead to the deterioration of financially valuable properties. Buildings with very large roofs, such as churches and schools erected without guttering or any adequate arrangement for drainage, have caused instances of erosion at certain mission stations which are probably the most striking to be seen in Buganda.

It will be convenient to consider these two aspects of the problem separately, and in each case to deal with the menace under its two heads, of (*a*) run-off from the compound, and (*b*) run-off from the roof.

Erosion from African homesteads

The most obvious preventive measure is a better selection of sites. Level land should be chosen for hut-building wherever possible. In most parts of Buganda, however, there is little level land available and it is almost unavoidable that the house shall be built on the side of a hill, and often on very steep slopes. In this case, it is of vital importance that the area levelled around the hut at the time of building should be as large as possible. The African usually levels, by dipping into the side of the hill, a space just large enough to take the base of the hut, but this is not enough. The larger the area of level land round the building, the more it can absorb the run-off from the compound, and more especially from the roof, before the surplus floodwater spills over the lip of the terrace and plays havoc with the cultivated land below. One may in fact go a stage further and say that, ideally, the whole area surrounding the house should be bench-terraced to some distance.

The next great safeguard is to plant the whole of the compound with short grass. This is in fact the major remedial measure which has been practised in Buganda: it has given very worth-while results, and it is estimated that in certain gombololas (sub-divisions of the county) round Kampala 80 per cent of householders have made some effort to grass their compounds. A surface of bare trampled earth absorbs only a very small proportion of the rain that falls on it, leaving the rest to run off and cause erosion, while an area well covered with grass will absorb the greater part of the rainfall, even on slopes and during very heavy storms.

Unfortunately the tradition of the Baganda in the past has been to preserve a clean earth compound which is swept daily, and this tendency has been reinforced by the insistence of early medical officers that compounds should be kept clean in order to eliminate vermin, dirt, and fly and mosquito breeding places. It is probable that the intention only was that long grass should not be permitted near houses, and that rubbish should be swept up, but chiefs seem to have interpreted these orders as requiring bare earth compounds, and it has been difficult to counteract this tendency, which has undoubtedly been the cause of much serious erosion. Now, however, Buganda public opinion is swinging over as it appreciates the erosion menace, and the Medical Department has no objection to short grass in house compounds provided it is kept in good order and cannot harbour vermin. At the same time, where the bulk of a compound has been grassed, the retention of a small area of bare earth is permitted, as many conservative Baganda housewives take pride in the daily sweeping of the space before their door. Also, up to the present, it has been the custom of Baganda to dry their crops on the bare earth compound, and although the drying of cotton, coffee and other quality crops on mats, reed

tables or cement floors is now urged, it is difficult for a man to provide enough of these for all his crops, and no exception is taken to a small bare earth space being kept for the drying of such crops as beans in the pod or sorghum heads. The short grass is unsuitable for drying crops on because the dew leaves it damp for such a large proportion of the day, but during the hot part of the day it is used by many Baganda for spreading out clothes to dry, and this is an advantage which has influenced many in planting their compounds with grass.

Of the types of grass used in planting compounds, *Cynodon dactylon* ("French" or "Bermuda" grass) and *C. transvaalensis* ("Masindi" grass), both known in Luganda as *ajijja,* are the most widespread. The latter is the more popular. Both are easily propagated by dividing clumps, and root well and spread with astonishing rapidity on the hard infertile soils of old compounds. Masindi grass makes an extremely neat cover for the first year or two, but has the disadvantage of dying out in patches during a drought, or in any case after two or three years, and letting weeds in unless replanted. The next most popular grass is *Paspalum notatum,* an introduced grass which is still in short supply and not equal to the demand on it in most areas. This grass is more robust than the Cynodons mentioned and withstands heavy trampling and does not die out; on the other hand it is difficult to establish a thick cover of it on a very poor soil, and if not cut it has more tendency than Masindi grass to grow just long enough to shelter such vermin as rats and snakes. *Paspalum notatum* is normally propagated by divisions: it can be multiplied more rapidly by sowing seed, but in my experience this is a slow and uncertain method unless more care is taken in obtaining seed at exactly the ripe stage than is possible under district conditions. In Uganda this grass does not usually flower except just after sowing or transplanting, or when disturbed by digging around it. Another introduced grass which is being tried for planting the compounds of African houses is *Eremochloa ophiuroides,* which appears to have much the same merits and defects as *Paspalum,* but perhaps looks somewhat neater.

It must be said at once that all these grasses need cutting to keep them in good order; in fact in the case of *Paspalum* some medical authorities do not approve it for compound planting unless it is cut regularly, as there is a possibility that it may grow long enough to hide vermin and also the breeding places of mosquitoes. This cutting is a problem for the peasant without a mowing-machine, but is fairly easily overcome by the use of crude slashers made of baling iron which are commonly found all over Uganda. The average area of compound per house in some surveys carried out in the Masaka district of Buganda was 0.06 of an acre, and as stated above not all of this would usually be planted with grass; so that the labour of slashing the grass occasionally, even with a crude instrument, is not very great, and in fact large numbers of people are now carrying it out.

Medical advantages in favour of planting grass in compounds are the reduction of glare and the elimination of disease-carrying dust.

In the last year or two, a number of peasants in Buganda have planted their compounds with low-growing flowers, chiefly Verbena and Portulacca, hoping in this way both to beautify them and to answer the purpose of checking soil erosion. Although the idea is praiseworthy, the practice is not worth encouraging for the average compound, as these flowers do not bind the soil so well as grass, are easily destroyed by chance trampling, and are difficult to keep free of weeds.

In some old compounds, where the topsoil is all eroded away and only compacted subsoil is left, it is impossible to establish grass without deep cultivation and sometimes levelling and even bringing in topsoil from elsewhere. Where labour is not available for all this work, it is sometimes a practicable method to peg down logs or sticks or banana stems at frequent intervals over the compound across the slope; after a few storms, these will have collected pockets of loose soil on their upper sides in which it is possible to establish lines of grass which will later spread over the intervening patches.

Another anti-erosion measure of importance in large compounds is the planting of hedges along approximate contour lines. These can very often be fitted in to bound the upper and lower sides of the compound, or in a very large compounds a hedge in the middle may be desirable as well. On steep slopes, examples can be seen of such hedges holding up considerable amounts of soil which would otherwise have washed away. Compound hedges are becoming quite popular with the Baganda, and the idea is often readily taken up if suggested. The hedge plants which are most liked by the people are: *Hibiscus, Panax, Cupressus macrocarpa* or *lusitanica, Lantana,* and *Cassia bicapsularis.* All of course need trimming to keep them neat, and it is of particular import-

ance for anti-erosion work that the hedges should be thick at the bottom with strong low branches. At the Nsangi Soil Conservation Area attempts have been made to train Africans to do this work with shears for a neighbouring group; and it has also been found that quite good pruning can be done by beating the sides and top of the hedge with a thin whippy stick, provided that this is done at frequent intervals before the branches have time to thicken too much. Otherwise, a knife must be used, but this is a slow method of trimming.

The second part of the problem is erosion caused by run-off from the roof. It is of course a fallacy (since no rain enters the house in either case) to suppose that run-off is very much greater in the case of an iron or tiled roof than a well-thatched grass one, except in so far as the former are often larger in area. On the other hand, the impact on the ground of run-off from an iron roof tends to be greater than that from a grass one, both because the former generally ends higher above the ground and because the water is concentrated by the corrugations. In the simple case of grass-roofed huts which are individually small, it is often sufficient merely to grass the compound to absorb most of the run-off from the roof also. In this case, care should be taken that grass is planted right up to the walls of the house so as to maintain a grass cover directly under the eaves, and absorb as much of the water as possible where it first drips. Sometimes, however, owing to waterlogging or lack of light under the eaves, it is difficult to establish grass in this position; and in this case the best thing is to place a broad line of stones under the eaves, so as to absorb a certain amount of water and to prevent erosion of the surface by the impact of the drip.

In cases where this is not sufficient, for example where exceptionally large roofs are concerned, it is necessary to take other measures. One method is to observe the lowest corner of the ground round the house, to which the run-off naturally tends to drain, and then to make ditches under the eaves to lead the water along to that corner. From there a ditch is made by which the water is led away to somewhere where it can discharge without danger of erosion, usually into tall standing grass or into a pit which is dug for the purpose. If the latter is used, it is important to remove at frequent intervals the silt which accumulates in it. Under Uganda conditions the water in such a catch-pit normally disappears within a few hours, and is gone long before any danger of mosquito breeding arises. In one case where the water tended to remain, the pit was filled with stones, ending with a layer of small stones, the idea being that the water-level remained somewhere among the stones and there was no surface which was accessible to mosquitoes for egg-laying. A soakaway pit of this type needs, of course, to be much bigger as the stones take up so much of its volume.

An alternative method, which will absorb the run-off from some roofs, is to have a moat, which is capable of holding a good deal of water, all round the house directly below the eaves. This is occasionally seen in Buganda where mud for building the walls has been dug up from directly beside them. A log bridge across the moat gives access to the door. Such a moat may be about 18 in. to 2 ft. deep, and again the water appears to be absorbed within a few hours and there is no mosquito menace.

Erosion from buildings of European type

The basic problems are the same for the European type of building as for the African. Again, it cannot be too strongly emphasized that at the time of erection a really large platform should be made on which the building is to stand. Cases have been seen where the run-off from large church or school roofs was safely absorbed though they had neither gutters nor provision for drainage, solely because they stood on a really large flat terrace. Bench terracing of the surroundings of buildings, which is little more than ideal for Africans, should be practicable for many schools and other public institutions.

When it comes to the grassing of compounds, a much wider choice of grasses is possible to the possessor of a lawn-mower than to the African with his slasher. Many a lawn in Uganda has been made by the simple process of clearing and levelling and then allowing natural grass to come in and keeping it mown; the mower forces all the grasses to assume a prostrate habit, and many weeds are destroyed by its selective action. While this procedure cannot be recommended as producing a fine-quality lawn for a private garden, it is a cheap method of obtaining a short cover which will prevent erosion; its effect may be seen on any of the local golf courses. Selected indigenous grasses such as *Brachiaria decumbens* (known to some Baganda as *kifuta*) and *Axonopus compressus*, will also produce quite a good sward when regularly cut with a lawn-mower. Kikuyu grass (*Pennisetum clandestinum*) is of course useful in the high-altitude districts (Kigezi, Bugishu, Toro), and has also been used for lawns at as low atitudes as places in Masaka District.

One other grass which should be mentioned is *Cynodon plectostachyum* (Luganda *kalandalugu*), which, although not generally regarded as a lawn grass in Uganda, is useful where a rough cover is required over extensive areas, such as aerodromes, parade-grounds, and the like. It has the double advantage of taking readily on poor compacted soils, and of spreading very quickly by runners; it can be left to its natural growth or cut, according to the closeness of the cover required.

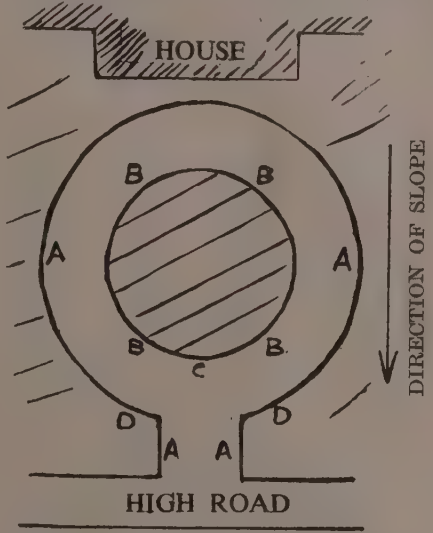
A useful method of assisting the establishment of grass where subsoil has been bared in the levelling process is to spread a mulch of elephant grass over the surface; if there is any slope on the site at all, this will soon catch some loose earth into which grass roots can penetrate. This method was used with success during 1941 on difficult parts of the Kampala aerodrome. It may be used either to obtain a cover of natural grasses or prior to the planting of *kalandalugu*.

Grass planting around buildings is the simplest, the most widely efficacious, and the cheapest method of controlling erosion. As in the case of Africans' compounds, the menace of this form of erosion has recently begun to be realized by non-natives in Uganda, and it is satisfactory to record that much grass planting has lately been carried out at mission stations, schools, P.W.D. road camps, and similar sites.

One type of erosion which is commonly seen in the compounds of both private houses and public buildings is erosion along the drive. Many occupiers are very careless about the upkeep of their drives. The lack of a few simple precautionary measures results not only in a constant recurrence of unnecessary expense in maintenance and repair of the drive, but also in many cases in the deposition of loads of silt on the highroads and ditches which involve the public authorities also in needless expense. The protection of drives against erosion is in essence the same as that of roads, which has been sufficiently described elsewhere (see, for instance, Colin Maher, "Roads and their Relationship to Soil Conservation", *East African Agricultural Journal*, May, 1940). There are, however, certain special points which arise in connexion with drives. While it is often desirable to grass the ditches, drive ditches are frequently very narrow: when grassed over it is difficult to keep the grass short, and the result is that the ditches become choked. It is therefore suggested that all owners of lawn-mowers should make their ditches the width of a mower and sufficiently flat and free of stones; cutting is then easy, and a very neat grassed ditch can be maintained.

Another difficulty often experienced by drive owners who grass ditches is that weeding of the drive results in a steep edge being formed on the inner side of the ditch where grass meets gravel, the run-off water tends to run along inside this edge, and to form another ditch on the side of the true ditch. The solution to this is, of course, as in the case of roads, to make "scrapes" every few yards to lead off the water into the proper ditch. On a drive such "scapes" need only be of the width of a hoe, and need not be deeper than just to cut through any grass edge which has been formed.

A more serious problem is that of the circular drive, which is often encountered and which in a hilly town like Kampala is responsible for a great deal of erosion. The problem may be explained by the following diagram:—



The drive in the diagram, like any other, has a ditch on each side of it for drainage purposes. The ditches on the outer sides, running through the four points marked A, pass out on to the highroad and drain into the storm water system in the usual way. The ditches on the inner side, passing through points B, have nowhere to discharge to; all their water is brought to point C, and then has no alternative but to flow down somewhere over the centre of the carriageway, at the same time scouring out runnels on the drive and carrying gravel and silt down on to the high-road. There is no doubt that systems of this kind have been responsible for much erosion and expense in upkeep in the past. The only solution (unless the whole drive and its ditches can be tarred) is to dig a catch-pit at C where the water is

collected and from which it is carried away through some form of pipe or culvert under the drive to point D or D1 where it can join the normal drainage system. In my experience, I have found that an ordinary length of galvanized iron down-pipe laid under the drive is satisfactory for this, and if deeply embedded in the gravel it seems to stand the passage of even loaded lorries without being crushed.

There remains the question of run-off from large iron or tiled roofs. The best plan is, of course, to fit cutters and lead the water away to storage tanks. Where tanks cannot be afforded, gutters are still useful for leading the water to one corner where it can be led away through a ditch system. Where the run-off from a large roof has resulted in a number of gullies being formed (as is frequently seen around churches and schools in Uganda) it is often best, instead of attempting to block up all these gullies, to select the most suitable of them and use it as a deliberate drainage channel, blocking up all the others and leading the run-off into the one selected. A drain of this sort should be stabilized by being straightened and graded, and having the banks cut back to a gentle slope and planted with grass, while the bottom may be planted with grass or, if on a steep slope dealing with much water, should be lined with stones or bricks.

It is generally stated in soil conservation text-books that storm drains used to carry surplus run-off should not be at a steeper gradient than 1 in 200. It can confidently be said that in Buganda, with our heavy soils and lush growth of protective vegetation, much steeper gradients than this can be used for the type of work we are considering without serious harmful effect. Exact gradients that can be used for different types of drain have not been worked out, nor are elaborate specifications much in demand in Uganda, where skilled supervision is rarely available to make use of them. Mr. Maher, in the article referred to, states that road drains in Kenya may safely be as steep as 12 or 15 per cent if covered with Kikuyu grass or star grass (*Cynodon*); in Uganda, *Paspalum notatum* is recommended for use in protecting such drains, and my experience is that with this grass still steeper gradients may safely be used. The sides of such ditches should be cut back to a gentle slope, both to prevent them falling in and to enable the grass to establish a good cover. Mr. Maher states that "while compact earth has an angle of repose of 29° to 50°, wet clay has an angle of respose of only 16°". I doubt, however, whether, with *Paspalum*, the banks need be cut back to this lowest figure for shallow ditches, though it may be necessary for deep old gullies. Deep gullies which are being retained for use as storm drains should have bridges thrown across them at points of passage to prevent the banks being worn down by trampling. The depth to which it is desirable to take storm drains may depend on the soil formation; normally they should be quite shallow, but in Mubende District on the granite formations there is a very light topsoil which is easily erodable, but in places is underlaid by a compacted subsoil at a depth of a few feet which forms a natural check on gullying and down to which the drain should be dug to obtain a firm foundation for it.

Drainage channels made with cement or regular brickwork need no discussion in this connexion as any gradient can be tackled, as well as curving courses, by those who are fortunate enough to be able to afford to make them. The danger spot for such drains is the point where concrete ends and the water is discharged on to bare earth; this must be very carefully protected by vegetation or by a stone or concrete apron where there is a drop off the concrete channel. Soil conservation text-books state that the length of such a protective apron should be 1½ times the height of the drop on to it. Those who build cement drains should remember that no water is absorbed in its passage along them; ideally such drains should discharge into a river or swamp or at least on to practically flat land. They must never be left to discharge down steep slopes, and the outfalls of all such drains should be periodically inspected to see that erosion is not occurring and that the vegetative cover is adequate for the outflow to be absorbed.

In the case of buildings where a storm drainage system is not needed, one of the systems recommended for Africans' houses, or a modification of them, may be used. For instance, for small buildings without gutters, a good plan is to dig a trench about 2 ft. wide and 2 ft. deep under the eaves, and fill it with stones, topping off with smaller stones and finally gravel. Such a trench will often absorb the whole of the run-off. This method is suitable for small school buildings, and has been used for them with success at Nsangi and elsewhere. Objections have, however, been made to the provision of a percolation trench close to the foundations, on the grounds that it tends to cause subsidence.

It is obvious that there are many other methods which could be devised, in fact there is endless scope for ingenuity and commonsense in this type of work. It is hoped that enough has been said in this article to indicate the lines on which the outstanding problems can be tackled.

(*Received for publication on* 31*st July*, 1943)

PRODUCTION OF RENNET ON THE FARM

By H. S. Purchase, Kabete

Rennet is an enzyme found in the stomachs of sucklings. When this enzyme is added to fresh milk it produces coagulation or curdling of the milk.

Up to now it has been possible to buy rennet tablets or liquid rennet for domestic and dairy use. Supplies are now difficult to obtain and several inquiries have been received at the Veterinary Laboratory, Kabete, asking how rennet can be prepared. After certain trials and experiments two methods of making rennet have been developed, the one producing liquid rennet and the other dry rennet.

Choice of Calf.—A calf 10-20 days old and in good health is chosen. If the calf is over two weeks old it is advisable to feed it on milk alone for two days prior to slaughter. The presence of grass or concentrate foods in the stomach complicates the cleaning of the mucous lining when preparing the rennet.

Preparation of Stomach.—The calf is killed and the fourth stomach or true stomach (also known as the abomasum) is removed as soon as possible. After slitting it open, the stomach is scraped very gently with the edge of the hand to remove the contents. If the calf has been fed on milk only, these will consist of milk curds in various stages of digestion. On no account should the stomach be washed as the water will remove a considerable proportion of rennet.

Place the opened stomach on a wooden board with the inner lining uppermost. Then with a knife scrape this lining off and collect it carefully. The mucous material comes away as a semi-liquid, gelatinous mass with shreds of the lining embedded in it. When all this lining has been removed there remain only the muscular and outer coats of the stomach, which are discarded.

Liquid Rennet.—The gelatinous mass is ground with boiled river sand in an ordinary mortar and pestle. When thoroughly triturated it is added to a whisky bottle of cold, boiled water to which have previously been added 7 grams (2 drachms or 2 teaspoonfuls) of boric acid, 35 grams (1 oz.) of common salt and 3 c.c. (1 drachm or teaspoonful) of strong hydrochloric acid.

The mixture is well shaken and kept in a cool dark place for five days. It is then filtered through muslin and bottled. The strength of the rennet varies from brew to brew and also with the age of the calf used. A teaspoonful of it should coagulate half-a-gallon of milk at blood heat in six minutes.

Dry Rennet.—Collect the stomach lining as described above. Mix this thoroughly with 2 oz. of salt and add 1 gram (⅓ of a teaspoon) of boric acid. Spread this mixture thinly on a large clean dish or on several panes of window-glass and allow to dry in a warm well-ventilated place, such as the kitchen, but be careful not to allow the temperature to rise above blood heat (38°C. or 98°F.). While drying it should be kept in the dark or at least protected from direct sunlight. Drying should be complete in 2-3 days. Collect the dry material and powder it. Keep stored in well-stoppered bottles in a cool, dark place.

To use the powder, take sufficient to fill a salt spoon and add to a tablespoonful of water. Allow this to soak for at least half an hour and shake at frequent intervals. Then add the liquid to a quart of milk, squeezing it through a piece of muslin to strain out any coarse particles of tissue.

The yield of rennet from a calf, calculated as the amount of milk which can be coagulated in a given time, is approximately the same by the two processes. Both rennets keep well in a cool dark place for at least two months, but it is probable that the dry powder will keep for a very much longer period. On the other hand, the liquid form is probably the more simple to use when small quantities are required at frequent intervals.

When making cheese the usual preliminary test should be made to determine the quantity of the rennet to be added to the bulk supply of milk.

(*Received for publication on 6th September*, 1943)

The danger to Africa from the present conflict lies chiefly in the aftermath, when a weary, disrupted, and bitter Europe may cast off the caution that lately has guided the management of African affairs and seek once again quick bonanza returns that do not exist except by sacrifice of the continent's resources and integrity.

Dr. R. U. Light in *Focus on Africa.*

THE LAWS OF HEREDITY

The same with plants—potatoes 'tatoes breed—
Uncostly cabbage springs from cabbage seed;
Lettuce to lettuce, leeks to leeks succeed;
Nor e'er did cooling cucumbers presume
To flow'r like myrtle, or like violets bloom.

"Canning or Frere nearly a hundred and fifty years ago", *Chemistry & Industry.*

SEED TESTING FOR FARMERS

By R. M. Nattrass, B.Sc. (Agric.) (Lond.), Ph.D. (Lond.), D.I.C., Senior Plant Pathologist, Kenya

Few farmers nowadays would consider the purchase of fertilizers and feeding stuffs without first obtaining from the merchant a declaration as to the composition or percentage of the essential components in order to have a basis for estimating the comparative values of the substances offered. Firms of repute standardize their products and only very small variations are likely to occur in proprietary fertilizers, feeding stuffs and the numerous branded substances commonly used in agriculture. A fruit grower, for instance, who did not know the strength of a brand of lime sulphur, would not only be unable to judge whether it was more or less expensive than other brands but also unable accurately to compare its effect. On the other hand, he would know that lime sulphur of known strength could be relied upon to give results similar to those of any other brand of equal strength. These branded substances have, in fact, been tested and a farmer is in a position to know within limits, what results he may expect from their use.

The analysis and testing of seeds offers to the grower similar means of assessing with a considerable degree of accuracy the value to him of seeds which he may buy or intend to sow. Seed testing also offers to him the protection of knowing whether or not he is running the risk of introducing injurious weeds or inferior crop plants to his land, both of which may, to a certain extent, nullify the efforts he has spent on proper cultivation. It is at least, a form of insurance which farmers would do well to take advantage of.

There is little doubt that the increase in the numbers of injurious weeds on agricultural land in Kenya and of weed seeds in grain sent to the mills is, in part at least, due to the sowing of seed containing a high proportion of weed seed.

It is obvious that farmers should ensure, as far as possible, that their efforts at weed control should not be off-set by inadvertently replenishing the stock of weeds at each sowing. Kenya millers have recently had occasion to draw attention to the increasing amounts of *Datura* and Darnel in grain received at the mills. Dodder has spread throughout the flax-growing areas and has undoubtedly been distributed with the flax seed. Many weeds of temperate climates have now established themselves in the Kenya Highlands. In addition to dodder, for example, *Camelina sativa* is common in flax and many other weeds such as Spurrey, Chickweed and Charlock are as familiar to farmers in parts of East Africa as to those in Europe. The introduction of such aliens can be attributed to inadequate control of past seed importations. Many other plants from different parts of the world have found a congenial refuge in this country.

When a sample of seed is submitted for analysis, it is divided by the analyst into pure seed and impurities. Pure seed may be defined as that part of the sample which consists only of seeds of the kind of which the sample purports to be. The impurities consist of what is known as extraneous matter, such as other seeds, and inert matter. Inert matter consists of portions of seeds or fruits, chaff, soil, etc. There are certain conventions, which need not be considered here, as to whether or not immature or broken seed of the right kind shall be placed in the pure seed or inert fraction.

The results of the purity analysis are given as percentages of pure seed and impurities by weight. Although a small percentage by weight of impurity or useless matter may mean nothing worse than the purchase of so much rubbish, the nature of the impurities is of importance. Thus, a bushel of wheat with a purity of 94 per cent will contain 4 lb. of useless matter which might not be considered a serious financial loss per acre. The situation with regard to weed seeds cannot be regarded with equal equanimity. The seeds of most weeds are much smaller than the crop seeds with which they occur. A very small percentage of the seeds of any weed may represent a very large number. Thus, a pound of seed containing 1.0 per cent of *Datura*, one of the largest weed seeds, carries about 1,400 seeds of the weed, equivalent to about 88,000 seeds in a bushel of wheat. Most weed seeds are very much smaller, so that a similar percentage would mean much greater numbers. For instance, flax seed containing 0.1 per cent of Charlock, a comparatively large seed, would—sown at the rate of two bushels to the acre—distribute something like eight seeds of Charlock to each square yard.

A farmer naturally wishes to know how his seed is going to germinate. For reasons which will appear below, the germination test is done on the pure seed after the removal of impurities during the purity analysis. A high germination is in itself desirable and most

countries where seed legislation is in force, stipulate minimum germination percentage below which seed cannot be sold or below which the germination must be declared. Small differences in germination percentage are not of great importance as, in contrast to the purity determination, it is based on numbers, not on weight. It does, however, give a very useful indication of the quality of the seed. For instance, seed of low germination may have been mixed with old seed, or be insufficiently matured or harvested under bad conditions. The test is particularly valuable when dealing with home-grown seed or any seed which has not been bought through a recognised dealer. It will also enable the farmer to decide whether heavier sowings than normal should be made. It is usual, when reporting on a test, to state the "strength" of the sample. This is the number of seeds which germinate after a stated interval. Thus, of two samples with a germinating capacity of 95 per cent, one may germinate 60 per cent in five days and the other 90 per cent in the same period. Other things being equal, the latter would obviously be the better proposition being likely to produce more vigorous plants and a more even crop. It might also mean that the slower-germinating seed had been held longer in store. The exception is freshly harvested cereals, which gain their full germinating power after a period of maturation.

With a knowledge of the percentage purity by weight and the germination capacity, it is possible to arrive at what a buyer really wants to know, that is, the percentage of pure germinable seed he is buying. This is known as the "Real Value" and is got by multiplying the percentage of purity by the percentage germination and dividing the product by one hundred. The figure enables a comparison to be made between the prices of any lots of seed offered, as it shows at once the number of pure seeds which will germinate or, alternatively, how much useless material is being paid for. The real value of a sample with a germination capacity of 90 per cent and a purity of 95 per cent is 85.5 per cent and is worth more than one with, say, a germination capacity of 95 per cent and a purity of 80 per cent, the real value of this sample being only 76.0 per cent.

Where facilities exist, it is always worth while for a farmer to have his seed tested, especially when the seed is home-grown or bought from other farmers. Providing the test is satisfactory, he will know that, in the event of failure, whatever else may be responsible, the seed was not to blame.

The quantity of seed used in a test is relatively small in comparison with the bulk. It varies from a minimum of eight ounces for the larger seeds to quarter of an ounce for most garden seeds. It is obviously important that a sample sent for test should be fully representative of the bulk. The following is an extract from the instructions with regard to sampling issued by the Official Seed Testing Station, Cambridge:—

"The following precautions, should be taken to ensure as great a degree of accuracy as possible in the drawing of samples. Where the bulk is believed to vary in quality even greater care is necessary:—

1. *Small lots stored in drawers.*—Thoroughly mix by hand in the drawer.

2. *In a small bag or part of a sack.*—Thoroughly mix by hand, either in the bag or after shooting the seed on to a clean floor.

3. *A full sack.*—Take samples from the top, middle and bottom of the sack. If the seed is small, e.g. clover seed, a metal seed spear may be used to penetrate the sack, and this will allow seed to be drawn from the different parts without difficulty. If the seed is not suitable for spearing it may be necessary to have part of the contents shot into another bag to enable the lower portions of the sack to be reached.

4. *A number of full sacks.*—Up to five sacks, sample every sack; over five and up to 50 sacks portions need only be taken from one sack in five with a minimum of five sacks; over 50 sacks, from one sack in ten with a minimum of ten sacks.

5. *Seed in heaps or bins.*—The sample must be obtained by taking portions from various parts of the heap or bin, and mixing them together. It is desirable to take portions from different depths in the heap as it is not sufficient to collect small handfuls from the surface.

In the three preceding cases (Nos. 3, 4 and 5), the bulk sample drawn will probably be larger than the test sample required for analysis. The portions which make up the bulk samples should therefore be put together into a clean receptacle, e.g. a seed scoop or a small measure, and thoroughly mixed. The sample for analysis, taken from this mixture, must be as representative of the bulk sample as the bulk sample is of the original bulk."

As is well known, there are a number of plant diseases which are carried by the seed. It is possible to detect some of these by microscopic examination and by certain cultural tests. An opinion can often be given as to the presence of Bunt or Smut spores, Leaf Spot of Celery, Pasmo, and other diseases of flax, etc., in a sample, if this information is specially asked for.

Facilities for seed testing are now being established at the Scott Agricultural Laboratories, Nairobi. Farmers in Kenya who wish to have samples tested, should send them to the Senior Plant Pathologist, P.O. Box No. 338, Nairobi.

[We are informed by the Tanganyika Department of Agriculture that seed-testing for that Territory shall be done at Lyamungu in the Plant Pathology Laboratory.—*Ed.*]

(*Received for publication on 22nd November,* 1943)

NUMERICAL ESTIMATION OF PINEAPPLES SUITABLE FOR CANNING

By A. K. Briant, M.A., Dip. Agric. (Cantab.), A.I.C.T.A., and G. E. Tidbury, B.Sc., A.R.C.S., A.I.C.T.A.

In producing pineapples for good-quality canning care must be taken that a large proportion of the fruit is of a size suitable for cutting into rings. The average size of fruit in a sample and the variation in size around the average are therefore of considerable importance. In Zanzibar it has been found that a pineapple weighing 4 lb. is about the smallest permissible for cutting into slices of $3\frac{5}{8}$" diameter which fit a can of standard A$2\frac{1}{2}$ size. It would thus be a loss to canners to purchase fruit below this size for the high-class canned-slice trade. The critical weight of pine, of course, differs for other can sizes but is of similar importance to the canner.

A simple method of estimating the proportion of fruit suitable for canning is therefore necessary unless large numbers of pineapples are to be individually measured or a proportion of the fruit purchased is to be found useless for canning-slices. In commercial practice it would be of great value to a purchaser, who knows the number and total weight of a consignment and consequently the average weight, to be able immediately to know the percentage of fruit falling below his critical canning weight and so to be able to adjust the price of the consignment.

Several thousands of pineapples have been individually weighed during the course of various field experiments at the Kizimbani Experiment Station, Zanzibar, and from the data collected in this way the relationship between the average weight of a sample of pineapples and the approximate number of fruits falling below a certain weight was established. Thus for a critical canning weight of 4 lb. Table I was prepared.

TABLE 1

Mean Weight of Sample in Lb.	Percentage of Fruit below 4 lb. in Weight
Lb.	*Per cent*
2·0	99·4
2·5	94·3
3·0	81·8
3·5	65·5
4·0	50·0
4·5	37·5
5·0	28·1
5·5	21·2
6·0	16·3
6·5	12·7
7·0	10·0

A graph may be constructed from these figures which would enable a buyer who knows the total weight of a known number of pineapples to read off the proportion which would be expected to fall below the critical weight. Such a curve would, however, be limited to use for one critical canning weight only and Fig. 1 has, therefore, been constructed in which the required information may be read off for any critical canning weight. The statistical considerations which underlie the construction of these curves are given separately as Appendix I.

As an example of the accuracy of the curves it may be noted that a large sample (not used in the above calculations) of 3,753 pineapples, representing the whole year's harvest from two experiments at Kizimbani, whose mean weight was 5.321 lb., had actually 25.1 per cent of fruit less than 4 lb. in weight. This compares with expectation of 23.4 per cent as read from Fig. 1. The difference is thus only 1.7 per cent —an error probably negligible commercially.

The curve has been used in assessing the value of experimental treatments where only the total weight and number of harvested fruit are known. The criterion of number of canning pines per acre frequently puts a different complexion on the result of an experiment. For example, the results of a manurial trial previously reported [1] indicated that dressings of sulphate of ammonia markedly increased the total weight, number and average weight of pineapples per acre. When assessed in terms of number of pines suitable for canning per acre the value of the nitrogenous dressings is shown to be even greater:—

Treatment	Number of fruit per acre	Average weight in lb.	Loss per cent	Number of canning fruit per acre
Sulphate of ammonia ..	2,537	5·31	23·5	1,941
No manure ..	2,438	4·33	41·4	1,429
Difference ..	99	—	—	512

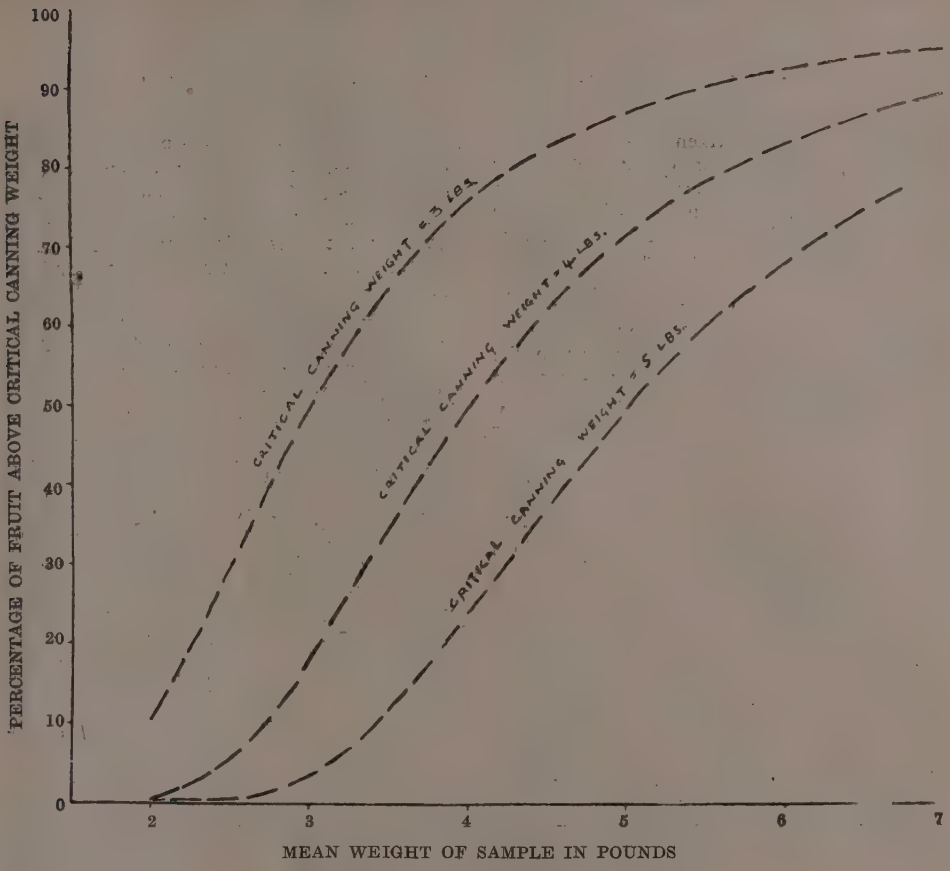


FIG. 1

Conversely, in a spacing experiment [1] the differences between treatments are decreased if considered as numbers of canning pines per acre:—

Spacing	Number of fruit per acre	Average weight in lb.	Loss per cent	Number of canning fruit per acre.
Close	7,848	4·27	42·9	4,481
Wide	3,180	5·47	21·6	2,493
Difference ...	4,668	—	—	1,988

SUMMARY

A graph is described from which the percentage of pineapples less than any critical weight may be read if the mean weight of the sample is known. This simple method of estimating in any given sample, the number of pineapples unsuitable for slice-canning is considered to be of use commercially and in assessing the value of experimental treatments.

REFERENCES

[1] Briant, A. K., and Tidbury, G. E.—*East African Agricultural Journal*, October, 1942. 80-84.

[2] Fisher, R. A., and Yates, F.—Statistical Tables for Biological, Agricultural and Medical Research, London, 1938.

Appendix I

Distribution curves of the individual weights of several thousands of pineapples were examined to see how far they depart from the normal. In some cases a slight departure from the normal is observed, in others none. The departure usually takes the form of slight asymmetry caused by moderately small pines being rather more frequent than moderately large ones, and very large pines more frequent than very small ones (i.e. the statistic g_1 is positive). A negative value of the static g_2 also indicates a rather flat curve in certain cases.

However, such departures from normality as have been observed are not large and it is considered that even if slight asymmetry in the distribution exists, it is still possible to calculate with reasonable accuracy the proportion of the fruit represented by portions of the distribution curve which lie further from the mean than any given distance. This may be calculated from the standard deviation and the mean weight by using the table of the normal distribution (or the Table of Probits) such as is given by Fisher and Yates [2].

This table indicates the probability of a variate falling outside the range, positive and negative, of any given deviation from the mean. In terms of pineapples, for any given average weight and where the deviation from it is expressed in pounds, the table gives the proportions of the sample less and greater than the mean weight minus and plus the deviation respectively. As fruit unsuitable for canning is almost entirely less than the critical weight (i.e. extremely large pines, unsuitable for slice canning, are very few in number and may be ignored) only the tail of the curve outside the negative deviation need be considered and this may be taken as half the total proportion indicated by the observed probability.

In comparing different populations of pineapples it is clear that increases in the mean weight accompany increases in the variability because whereas there is theoretically no upper limit in weight, the lower limit of the range cannot be extended beyond zero. (This also accounts for part of the slight asymmetry observed in the distribution curve.) It follows, therefore, that the standard deviation tends to become larger with increases in the mean weight. Any single estimation for the standard deviation, therefore, could not universally be applied in making estimates of pineapples unsuitable for canning.

In several experiments at Kizimbani the field treatments caused variations in the size of the pineapples and by recording the individual weights of all the pines reaped from plots of different experimental treatments it was possible to obtain several differing populations and calculate their means and standard deviations. An examination of twelve such differing populations indicated that their means and standard deviations were correlated, with a significant positive coefficient of 0.644. The figures were then used to obtain a regression coefficient and to calculate the expected standard deviations for any given mean weight from the equation:—

$$\text{S. D.} = 0.310 \times \text{mean weight} + 0.173$$

From this regression equation and the table of the normal distribution the figures given in Table I were prepared.

(*Received for publication on 1st September,* 1943)

SALIGNA GUM POLES

By S. H. Wimbush, Assistant Conservator of Forests, Kenya

Experiments carried out recently indicate that the Saligna Gum (*Eucalyptus saligna*) will not make a really good pole owing to its tendency to split from the ends, but that this splitting can be considerably reduced by cutting the trees several months before they are required for poles. After felling, the trees must be left intact with all their branches and the bark on for two months at least. This is to allow the leaves to draw out the sap from the bole of the tree. When the leaves have shrivelled up and died, the trees can then be cross-cut to the required length of pole. It will help to prevent the splitting if the cross-cut ends of the poles are bound with wire. Wiring will not, however, prevent end-splitting in a freshly-felled tree. Poles cross-cut directly after felling split badly at the ends and the splits extend down the pole. If the split ends are cut off a month or so afterwards fresh splits develop on the newly-cut ends of the pole. These are often worse than the original splits and make the pole quite unserviceable. A reasonably sound pole of Saligna Gum can, however, be got by the method described above. A further advantage of allowing the pole to dry out before cross-cutting is the greater ease of handling. A 16-foot Saligna pole 4 to 5 inches diameter at the top weighs 67-70 lb. when freshly cut, but only 35–45 lb. after two months seasoning. It takes two men to carry a green pole, but one man can carry a dry pole.

A PRACTICAL POLICY FOR TSETSE RECLAMATION AND FIELD EXPERIMENT

PART III

By S. Napier Bax, Tsetse Research Station, Tanganyika Territory

General Discussion

This paper has shown that there are many tsetse situations which can be cheaply remedied with the knowledge possessed to-day. These amenable situations form more than the mere fringe of the problem; they are part and parcel of the problem itself and must amount in the aggregate to several thousands of square miles. Cheap reclamation methods give East Africa the physical ability to reclaim large areas, and the reclamation of large areas means in its turn that the work can be extended to natural tsetse boundaries, instead of the artificial, expensive cleared barriers of the past. On the remedies discovered a practical East African policy of reclamation can and should be built. Cultivation steppe should never again be surrendered to the tsetse. The hardpan type of *Acacia-Commiphora* savanna can be reclaimed from *G. swynnertoni* cheaply by discriminative clearing, without recourse to fire-exclusion or organized fires. Where the thicket is light, *G. pallidipes* can be driven from thorn savanna and *miombo* wooding. The great plains, infested with *G. morsitans* or *swynnertoni*, or both species, can be cheaply reclaimed. *G. pallidipes, brevipalpis* and *austeni* can be dealt with reasonably cheaply where they occur as a linear problem. The *G. palpalis* problem can be met. The Medical Department of Tanganyika has found the answer to the Rhodesian type of sleeping sickness in concentration of the population. There is no reason to-day why towns like Dar es Salaam should any longer tolerate tsetse. In certain circumstances the tsetse position on alienated land can be greatly improved, but legislation is very necessary to ensure the co-operation of all owners. This is an impressive list which shows that there is some kind of a proved weapon against all save one of the important species of tsetse in certain of the common conditions in which they are found. There is lacking a method to reclaim the true habitat of *G. morsitans*, the *miombo* wooding. This is due not so much to the difficulty of the problem as to the curtailment of the Department's programme on account of the war.

The account which has been presented of the sadly reduced large-scale field experiments in being gives substantial hope that a cheap method of reclaiming *G. morsitans*-infested *miombo* may be discovered in the not distant future, either by fire-exclusion, along with the clearing of the special drainage valleys, or by the clearing of the drainage valleys alone. But more field experiments are urgently required to include the types of *miombo* wooding not covered by the existing experiments. The *G. swynnertoni* field experiments should also give valuable information on methods to reclaim a type of *Acacia mellifera* and allied *Acacia* country, to which it is doubtful if the proved hardpan clearing method can be applied. If success is obtained the Department should be able to deal with *G. swynnertoni* wherever it occurs. The more straightforward of the *G. pallidipes* situations can be remedied to-day, but a great deal more research and field experiment are necessary before this difficult tsetse is fully mastered. The other species of tsetses are not so important, but more research is required on them, particularly on *G. brevipalpis* where it occurs spread through a wide habitat, not in the easily tackled linear habitat.

There remains the important question of game and the tsetse. Southern Rhodesia has shown how open bush can be reclaimed by shooting. Would it be possible to reclaim the more open stretches of *G. morsitans*-infested *miombo* wooding by this means? It is a matter that urgently requires examination and it is most regrettable that the great game experiment has had to be closed down owing to the war.

The foregoing account completes the picture of the reclamation that can be achieved with to-day's knowledge and shows how the existing field experiments are directed to filling in the gaps, though the position will not be satisfactory until the field experiments abandoned on account of the war are taken up again and amplified in the light of recent findings. The Tsetse Research Department in Tanganyika is to-day accomplishing its avowed object—the object for which its funds were voted—namely the devising of means by which to recover cheaply the country from the tsetse. No new policy of revolutionary character is advocated in this paper; it relates merely the great progress that has been made, describes the pros-

pects and needs of the future, and urges that immediate use should be made of the knowledge already gained.

As with much other research, it has taken some years to reach the point when dividends are forthcoming on the investment. In the meantime—perhaps owing to despair that any method of eliminating the tsetse would be found—a school of thought has grown up to-day which tends to the belief that the extension of the bare, treeless cultivation steppe by sheer felling gives a sufficient answer to the tsetse-fly problem. Presumably exponents of this school find room in their conception for the development and utilization of the great *mbuga* systems, and for the reclamation of the bushed areas where the tribes concerned are purely pastoral, e.g. the Masai; but generally speaking they advocate the steam-roller method of reclamation, that is, the sheer felling of trees and thicket when more land is required. As the population increases, so it will be forced to cut down more bush, until perhaps in hundreds of years the tsetse-fly will have been pushed out of the country. But there is an even more extreme school than this, one that would persuade us that the tsetse is a blessing in disguise—that it is a trustee of the land against soil erosion, or a most useful weapon wherewith to force the natives into better methods of agriculture.*

Whether such views will continue to be held, when it is realized generally what tsetse reclamation the Department is undertaking and can undertake to-day, is not known, but it is well worth while examining in some detail what the cost would be were East Africa content to adopt the steam-roller method of sheer felling† as the sole means for dealing with the tsetse-fly.

(*a*) Cultivation steppe remains free of bush by virtue of the very heavy population it carries. This population is so dense that it is ruining the land. Improved agricultural practice has already done much and will no doubt do more to remedy the position, but it seems likely that one of the alleviating measures must be the reduction of the population by the encouragement of emigration. The result of this will be the upgrowth of bush on the worst agricultural land, an excellent prospect, for that land will then fulfil its rightful function as a timber reserve. Such stretches of bush will, however, form potential foci for tsetse carried from the fly-bush and may give rise to very dangerous situations.

(*b*) But even if bush is not allowed to spring up as in (*a*), no agricultural planning can afford to leave the cultivation steppe in the treeless condition it is to-day. Plantings must be made for fuel, timber, shelter and windbreaks. The cultivation steppe of to-morrow must present a very different picture to that of to-day and it will be far more vulnerable to the wandering and carried tsetse.

(*c*) Practical experience has shown that it is necessary to guard long stretches of the borders of cultivation steppe by "defence lines", and not even odd trees for shade or for aesthetic reasons can be left standing, for they act as collecting points for tsetse and as stepping-stones towards the treed areas in the heart of the steppe—treed areas which must be much extended in the ideal steppe of the future. With the expansion of the settled area by the steam-roller method of sheer felling, new "defence lines" will have to be formed and this process will be repeated indefinitely; the somewhat ridiculous and certainly expensive position will therefore arise of having to plant and wait for trees to grow where a few years earlier an abundance of suitable trees occurred in nature.

(*d*) This ruthless felling of trees would have to include all species of all ages; the immature trees of economically valuable timber which should grow up to supply to-morrow's needs will disappear along with the mature ones.

(*e*) Land is not all of equal value agriculturally; indeed much of it is poor. Were the steam-roller method applied, the expansion on the borders of the cultivation steppe would

* Gillman apparently advocates sheer clearing—steam-roller methods—in his recent article in this *Journal* of January, 1943, "A Geographer's Retrospect and Note on the Mpwapwa Land-Use Experiments and Achievements". This view also receives some support from Hornby in his article, "Pasture Management in relation to Tsetse Reclamation", in the same *Journal* for July, 1941, though it is quite clear from p. 55 that he advocates the elimination of the tsetse, provided the reclaimed land is properly cared for. The extreme view of tsetse as a blessing in disguise was, according to Lewis (this *Journal*, April, 1942, 188), first mooted by Kirkpatrick only to be firmly rejected by him. It was repeated by Jack and Whyte in *The Rape of the Earth: A World Survey of Soil Erosion*, but not so unequivocally rejected.

† The actual labour cost of sheer felling varies enormously, depending on the kind of vegetation, its density, the quality of the African labour, the quality of the tools and the amount of European supervision available. It is probably impossible to better 12 man-days per acre for average *miombo* wooding. The figure will nearly always be much exceeded, perhaps up to three times the original. *Acacia-Commiphora* savanna is more easily felled. The best figures recorded for paid labour are four man-days per acre, but it is safe to say that this figure will only very exceptionally be attained. Sometimes as many as 15 man-days are required. Thicket is of course very much more expensive to deal with.

doubtless first take place in the most favoured areas, yet the point must come, when to avoid dangerous peninsulas and islands of fly-bush, the trees on the poorest land must be felled. This would give an exceedingly poor return for the labour involved and would apply to large areas which could never be maintained by agriculture.

(*f*) It is an established fact that traffic—motor, cyclist and foot—entering cultivated country from areas where the tsetse-fly is thick carries with it many tsetses, and in important areas de-flying pickets to-day are posted on the main roads. Many more pickets are actually required, and were a forward tsetse policy adopted they would no doubt be supplied; but the annual expense would not be negligible and close supervision would be necessary, as it is to-day, to keep them efficient. Constant propaganda would be required to keep traffic to the picketed roads as far as possible. But it is not necessary to acquiesce indefinitely in this recurrent expense. The Department is working towards the elimination of the tsetse and its attendant pickets.

(*g*) The passage of stock through tsetse-bush results in severe losses and is also a potent factor in carrying testse into the settled areas.

(*h*) Were East Africa to resign itself to the presence of the tsetse indefinitely, sleeping sickness, though controlled, would linger on, taking a certain annual toll in lives and forming a constant expense.

(*i*) Were the steam-roller method of sheer clearing adopted, the fact that all the bushed areas would be abandoned to tsetse would mean that a great national asset remained untapped. It is true that many areas cannot stand heavy grazing without damage, but grazing in the reclaimed tsetse areas might be controlled as is contemplated in the settled areas. A very light live stock population per square mile would add up in the aggregate to very large numbers of stock. It might well be worth the while of the veterinarians to experiment to find out what stock *miombo* wooding and thorn savanna can carry without damage, what resting period is necessary and what controlled fire there must be to prevent the bush gradually becoming denser. This is an extremely important point in a country whose agricultural future must lie largely in stock-raising, and the bulk of whose backward people will certainly be dependent for many years to come on the natural, though (let it be hoped!) broadly "managed", pasture. The fate of the Individual Native Holdings scheme has shown the difficulties attendant on attempting to raise the native's standard of agriculture too rapidly, and too great store must not be set on the hope of converting the native quickly to the revolutionary idea of planted pastures and pasture management on a par with his present crop management. Doubtless that will come in time, but European standards of pasture management can only be inculcated on the mass of the people by gradual steps forward.

It is clear that acquiescence in the presence of the tsetse would put that insect into the position of a dictator, a dictator which would order the size of settlements, determine the manner of expansion, and exert a potent and restrictive influence on agriculture. In addition it would exact an enormous annual toll in human labour—a real financial loss, for that labour might have been turned into productive channels—and in animal health and lives. To sum up, the country would be developed to a pattern and form dictated by the tsetse.*

How much better to contemplate the opposite—a great tract of country from which the tsetse has been driven and to which it cannot return, standing ready for occupation and development by an increasing and eager people. Real planning can now play a full part. Administrator, medical officer, educationist, agriculturist, veterinarian, and water expert can mould development as they will. Native settlement of approved size will take place in approved favourable spots, the intervening poorer bushed areas will carry a light population of stock carefully controlled to avoid damage to the grass cover, but forming in the aggregate an immense contribution to the wealth of the country, and communications will be safe for animal and motor transport. It is impossible to suppose that if this ideal is attainable the white population of East Africa will be satisfied with less, and as regards native peoples for whom Great Britain holds the trusteeship, can she resign to the tsetse-fly, which will exact such a price for its domination, her privilege to plan and control?

* This question is so important that Lewis's (this *Journal* 6 (4), April, 1942, 188) excellent summing up must also be quoted:—

" . . . . . This view of a widespread, injurious pest in the guise of a protector of the country which it infests is, to say the least, strange. It depicts the surrender of a trusteeship to an agency which offers no assurance of release of the fly area, nor any security to the neighbourhood; it hinders development, and is continually threatening to take possession of additional land; it represents the exchange of one evil for another, both destructive."

The Organization Required to Implement a Tsetse Policy

It is suggested that the general tsetse policy of a territory should be formulated by a territorial tsetse committee,* composed of the Directors of the departments most closely concerned, viz. the Medical, Agricultural, Veterinary, and the Tsetse Departments, with the Chief Secretary as chairman. This committee would lay down the general principles to be followed and ensure that a forward policy was carried out. From time to time there would be inter-territorial meetings. The provinces would form their own provincial tsetse sub-committees, composed of the provincial officers of the above departments, and these committees might be responsible for local schemes which involved no financial calls on Central Government. Large reclamation schemes—those involving the expenditure of Central Government money and those embracing more than one province—would go before the territorial committee, as would requests for financial help from the Colonial Development and Welfare Fund. No doubt the provincial tsetse sub-committees would originate many of these large schemes. One important fact must be borne in mind. Committees must plan for five years ahead of reigning land requirements. No method of reclamation, except sheer felling, is likely to produce tsetse-free land in under two years, and more probably three or four. Even sheer felling does not immediately banish the tsetse.

The adoption of a tsetse policy will necessitate the formation of a practical organization to implement that policy in the field. (Sleeping sickness measures are not referred to here. The Sleeping Sickness Branch of the Tanganyika Medical Department already has its own organization.) In the author's opinion reclamation cannot be successfully undertaken except by specially trained experts whose duty it is carefully to survey and keep a watch on the tsetse position in the district or province, carry out the reclamation measures recommended and see that those measures are efficiently maintained. To carry out his duties the reclamation officer must have a full knowledge of the common species of tsetse and their habits; he must be fully conversant with the indigenous trees and capable of recognizing the various vegetational types and of bringing to the notice of headquarters any new ones that he may find; he must know the technique of testse survey and fly rounds; he must be capable of undertaking experiments as required from time to time by headquarters; he must possess a knowledge of laboratory work in connexion with tsetses; and finally he must be of such a disposition that he can readily co-operate with the other departments with which he must work in close contact—the Administrative, Medical, Veterinary and Agricultural—and he must be in sympathy with the native and European farming communities. The reclamation officer, though having these special duties to perform, must on no account be divorced from the research side. The two sides are complementary and they must reciprocate to their mutual advantage; visits between the two sides should be frequent.

A start has been made on these lines in Tanganyika, where provision for Provincial Tsetse Officers and Provincial Tsetse Assistants for the most important provinces, with the necessary subordinate African staff, has been made in the Tsetse Department's vote. Unfortunately the shortage of suitable European staff owing to the war makes it impossible to put into effect the full programme, but a beginning has been made—a solid foundation on which to build.

SUMMARY

The Nature of the Problem

The species of tsetses present in East Africa are enumerated, their vegetational requirements are shortly described and the trypanosomes they carry indicated.

The Reclamation that can be Undertaken with To-day's Knowledge

The reclamation that can be undertaken with to-day's knowledge is described. It includes:—

(*a*) The maintenance of the present boundaries of the cultivation steppe by "defence lines".

(*b*) The successful reclamation of the dry thorn savanna infested by *G. swynnertoni*, as has been carried out at Shinyanga by means of hardpan clearings (without fire-exclusion or organized grass fires). Cost one and one-third man-days an acre over whole area.

The application of this method to 75,500 acres of the Ukerewe peninsula has resulted in a very great reduction of *G. swynnertoni* and sleeping sickness. Cost half a man-day an acre calculated over whole area.

The successful application of this measure to a peninsula of *G. swynnertoni*-infested bush at Shinyanga is described.

(*c*) Thorn savanna and *miombo* wooding can be reclaimed from *G. pallidipes* by removing the thicket if the latter is not so extensive as to render the measure uneconomic.

The reclamation at the Mpwapwa Veterinary Headquarters is described.

* Mr. Lowe, Director of the Tanganyika Veterinary Department, was the first to make this useful suggestion.

(*d*) The great plains carrying a lace-work of vegetation of gall-acacia or other types of *Acacia*, and infested by *G. swynnertoni* and *morsitans*, can be reclaimed.

160,000 acres of the Huru-huru plains have been reclaimed from *G. swynnertoni* at Shinyanga at the cost of one-third of a man-day per acre, calculated over the whole area, and upkeep at one-eightieth of a man-day per acre per annum.

Similar operations in progress against *G. morsitans* and *swynnertoni* in the Kondoa district are described.

Plans have been worked out for extension of operations to the Northern Province, at the cost of one-half of a man-day per acre. Much of Masailand offers great scope for these measures.

(*e*) Where *G. pallidipes, brevipalpis, austeni* and *palpalis* live in linear communities, great stretches of the surrounding country can be reclaimed from the first three species by reducing the source of infestation to an open parkland. At Kingolwira the initial cost came to twenty-five man-days per acre.

G. palpalis is nearly always confined to narrow strips along the lake shore and rivers flowing into the lakes. Organized settlement can do much to rid the country of this pest. Symes' and Vane's method of "Block" catching out supplies an alternative method, at any rate for rivers.

(*f*) The Medical Department of Tanganyika has successfully solved the problem of small isolated bush villages afflicted with Rhodesian Sleeping Sickness, by concentrating the population into aggregations of at least 1,000 taxpayers.

(*g*) Towns and township areas can be protected from incursions of tsetse from without—generally *G. morsitans, swynnertoni* and *pallidipes*—by the establishment of pickets on the roads. The tsetses within—generally *G. pallidipes, brevipalpis* and *austeni*—can be dealt with by the destruction of the thickets.

The plans worked out for the reclamation of the Dar es Salaam area, of 31,250 acres, are described. The initial cost would be about three and a-half man-days an acre.

(*h*) The problem of alienated land is discussed. When a large proportion is land under cultivation, the same methods as in township areas can be applied. In other circumstances reclamation will be more difficult, but it may be possible to apply one or other of the methods already described. It is always worth while asking for a survey and advice.

Suitable legislation is essential in order to secure the united efforts of the owners. Government and the Native Authorities must be prepared to co-operate when the reclamation of adjoining land in their possession is necessary to the success of the scheme.

(*i*) Two other reclamation measures are described, viz. organized grass fires and the isolation of special vegetational areas.

Legislation

The necessity of suitable legislation is emphasized. Legislation falls under three heads:—

(*a*) Legislation for sleeping sickness control, that is sanction for the concentration of the population and subsidiary measures.

(*b*) Legislation for regulating traffic, which will chiefly consist in putting road fly-pickets on a legal basis.

(*c*) Legislation for the extermination of tsetse on private land.

The Prospect for Large-Scale Reclamation

If large-scale reclamation is defined as the reclamation of areas of over 32,000 acres (50 square miles), it is the fact that several thousand square miles of Tanganyika can be cheaply reclaimed with to-day's knowledge.

But this does not mean that the great mass of the fly-bush can yet be reclaimed irrespective of its composition. With the object of extending to-day's powers there is in existence a programme of field experiments which has unfortunately been seriously interfered with by the war.

The Progress of the Large-Scale Field Experiments

The field experiments in existence and the new ones that should be started are discussed.

(*a*) The effect on *G. swynnertoni* of fire-exclusion and clearing of the hardpans is most promising, and it has been found that *G. pallidipes* does not increase under these conditions.

(*b*) The effect on *G. morsitans* of fire-exclusion and clearing of certain drainage lines is also most promising.

(*c*) The effect on *G. morsitans* of merely clearing certain drainage lines is hopeful.

(*d*) The effect on *G. swynnertoni* of selective clearing is not yet clear.

(*e*) The effect on *G. pallidipes* of discriminative clearing of thickets has not progressed far enough to enable the results to be assessed, though a measure applicable to coastal conditions has proved hopeful.

(*f*) Reclamation by shooting the game. The experiment was closed down on account of the war at the end of a period of preliminary observation.

(*g*) Defence. New methods to replace barrier clearings are discussed.

The Application in Practice of the Known Methods of Reclamation and of Those it is Hoped to Evolve from the Large-Scale Field Experiments

Where man power is plentiful it should suffice, by modern methods, to reclaim the tsetse areas in its neighbourhood. Where man power is scarce, the modern caterpillar tractor can be employed on clearing and making firebreaks.

Natural boundaries to the fly-belts are described and discussed.

The northern portion of Tanganyika is shown to possess at least seventeen fly islands or "near-islands", varying in size from 300 square miles to 13,000, including protrusions into Kenya.

Reclamation would start at one end of a block, with the flanks resting on tsetse-free country, and would be gradually pushed forward, over a period of years if necessary. The reclaimed block would then stand inviolate without any danger of reinfestation by tsetses.

The cheap methods of reclamation that have already been evolved are largely applicable to the economically important Lake and Northern Provinces. Survey would probably show that the hundreds of square miles, which it is known can be reclaimed in these areas to-day, could be increased to several thousand.

The two great southern *G. morsitans* belts of Tanganyika are considered. The western belt is an island, but the eastern belt extends into Portuguese East Africa to an unknown distance. The problem is compared with the one that Southern Rhodesia is successfully meeting to-day. The possibilities of reclaiming these belts—not yet practical politics—are discussed.

General Discussion

The situations which can be tackled with to-day's knowledge are reviewed. They form more than the fringe of the tsetse-fly problem; they are part and parcel of the problem itself.

It is shown how the large-scale field experiments in progress are designed to fill in the gaps in the knowledge of practical reclamation methods, but more research and field experiments are required to take the place of the work abandoned owing to the war, and to explore avenues recently discovered.

In concentrating on the evolution of large-scale methods to rid the country of tsetse, the Department of Tsetse Research is doing the work for which its funds were voted. Considerable success has already been achieved and the knowledge gained should now be applied in practice.

Progress has taken time, and despair that any successful method would be found is perhaps responsible for a school of thought to-day which advocates sheer clearing of bush as the sole means of reclamation. This view is examined in detail, and rejected. The alternative is sketched, namely tsetse-free country in which all departments can combine to mould development unhampered by the tsetse.

The Organization Required to Implement a Tsetse Policy

A territorial tsetse committee, composed of all departments closely concerned, is advocated. This committee would lay down the general principles of a tsetse policy, and consider the large-scale reclamation schemes.

From time to time there should be inter-territorial meetings.

Tsetse sub-committees are suggested for the provinces, to deal with the smaller local projects; they would also no doubt originate many of the larger schemes.

The adoption of a tsetse policy necessitates a practical organization in the field. This should be composed of expert, trained men and must be closely associated with the research side of the Tsetse Department.

A practical organization of this nature has been started in Tanganyika, but shortage of suitable officers on account of the war is severely hampering progress.

ACKNOWLEDGMENTS

Mr. Potts has kindly read through the text and made valuable suggestions, for which the writer expresses his thanks. Many photographs come from a collection of the late B. D. Burtt, Botanist of the Department, and presented to the Department by his brother, Dr. E. Burtt. To those others who have kindly lent photographs the writer is grateful.

POLITICAL CONSCIOUSNESS

We have come to a stage where we can hope that at last men can be conscious of the working of the society in which they live, and that they need that consciousness to avoid being crushed by the society they had unconsciously developed.

One aspect of this new consciousness is the transformation of state machinery from a tradition-ridden bureaucracy, permanently at loggerheads with an acquisitive industry, into an orderly and scientific organization for satisfying human needs. I am under no illusion that the transformation can be an easy or painless one, but the very urgency of the situation which makes the change imperative for survival removes at the same time many obstacles that would have seemed insuperable in the past; and we may still hope to see the change carried out effectively before it is too late.

Prof. J. D. Bernal, F.R.S., at the meeting of the British Association, September, 1941.

A LEADER OF RESEARCH

I should like to state some of the more obvious reasons for Rutherford's extraordinary power as a leader of research. First, of course, there was his own unique and apparently almost intuitive grasp of the essentials of a problem. Next his interest in the course of an investigation and his impatience to know the result were so passionate that they inevitably infected even the laziest of his co-workers. Then there was his incorrigible friendliness to even the least worthy of his research men; a man who is invited regularly to Sunday supper at his professor's house, who meets him nearly every day across the laboratory tea-table, who is generally treated as the social equal of an emeritus professor, and who is constantly and pointedly asked how his work is getting on, is likely to do more and better work than one who is left to feel that nobody wants him or his results very much.

Prof. H. R. Robinson, F.R.S., quoted in *Nature*.

COLLECTED RECIPES FOR INSECTICIDES

By W. Victor Harris, Entomologist, Department of Agriculture, Tanganyika Territory

War-time restrictions have reduced the number of ready-made insecticidal preparations available to the farmer and gardener. Since the pests are still with us, a collection of simple recipes for insect control is offered, utilizing such ingredients as are likely to be available in East Africa. The source of each recipe is not acknowledged individually, but the writer wishes to express his indebtedness to entomological literature generally.

"Don't worry, it may never happen" is a comfortable doctrine much in favour by growers of crops, whether in window-boxes or fifty-acre blocks. It saves trouble in buying sprayers, mixing insecticides, and, sometimes, in harvesting the crop. People who would never think of running a motor car without first insuring it, will spend twenty or thirty shillings on flower seeds for the garden and not one shilling on insecticides—just another form of insurance—or worse still spend large sums of money planting out fields of tobacco, or onions without first baiting for cutworms; in fact taking a chance on the non-arrival of pests at most unattractive odds. The best results in controlling pests are obtained by tackling the insect before it is sufficiently numerous to cause permanent injury to the plants. This means baiting for cutworms *before* planting out; spraying for coffee-bug at a time when local knowledge suggests that increase in numbers is likely; regular spraying of young cabbages and cauliflowers to stop cabbage-aphis ever becoming numerous; dusting turnips, and garden plants such as *Alyssum*, to kill off the first generation of sawfly grubs; and most of all it means having suitable sprayers in working order and a reserve of insecticide ready for application when their use is most effective. To adapt an old saw "the early spray catches the worm—before it gives rise to a hundred more."

In the following recipes *soap* means ordinary household soap. Soft soap, especially potash-whale-oil soap, is preferable for making up insecticides but it is now hard to come by; if available, use three quarters of the weight given for hard soap. Thorough mixing for all sprays is essential if damage to foliage is to be avoided. Details for the preparation of such sprays as lime-sulphur which are not easy to make in small quantities and are usually employed only on a field scale, can be obtained from the writer.

CUTWORM BAIT (1)

Paris green	5 lb.
Sugar	10 lb.
Water	5 gallons
Bran	100 lb.

If white sugar is used the poison, bran and sugar may be mixed together dry and bagged. The water is then added until the bait is moist but does not drip when squeezed in the hand, when required for application on the land. If brown native sugar or molasses are used, poison, sugar and water should be well mixed and then sprinkled over the bran, stirred in and the mixture left for an hour or two before spreading. Cutworm baits are best applied in the late afternoon, and on land free from weeds.

CUTWORM BAIT (2)

Sodium fluoride ..	5 lb.
Molasses	1 gallon
Water	5 gallons
Bran	100 lb.

Preparation as in (1). Sodium fluoride is not poisonous to man and live stock in the ordinary way, whereas paris green is an arsenical and must be used with due care.

CUTWORM BAIT (3)

Sodium fluoride	7 oz.
Water	2 gallons
Prickly pear	2 gallons

Dissolve the sodium fluoride in the water. Then chop up segments of prickly pear into approximately one-inch cubes, measure the required volume and add to the solution. Allow to soak for twelve hours, then drain and scatter in the garden. This bait remains attractive longer if protected from the sun by leaves.

GRASSHOPPER BAIT (4)

Sodium arsenite ..	1 lb.
Sugar	1½ lb.
Sorghum meal (machine ground)	50 lb.
Washing blue	½ tablet

Mix well together on a tarpaulin or smooth cement floor. Bag until required. For use add water until a crumbly mass is formed, allow to stand if possible for about twelve hours, then sprinkle lightly over the infected area taking care that the bait does not come in contact with crops or they will be scorched. This bait gives good results against the elegant grasshopper.

LOCUST HOPPER BAIT (5)

Sodium arsenite ..	3 lb.
Molasses	½ gallon
Water	8 gallons
Coffee parchment ..	100 lb.

Dissolve molasses and arsenite in the water and sprinkle over the coffee parchment on a smooth cement floor. Mix well. If not required for immediate use, the bait can be dried in the sun and then stored in bags. From 100 to 200 lb. per acre are required in practice, according to the amount of vegetation on the ground.

HARVESTER TERMITE BAIT (6)

Sodium arsenite	½ lb.
Sugar	4 lb.
Water	4 gallons
Dry grass	*ad lib.*

Dissolve arsenite and sugar in the water, then soak dry grass in the solution for a few minutes, afterwards drying out again in the sun. Place small heaps of the bait near the holes in the ground from which the termites emerge. Keep stock away from baited areas for a few days with thorns.

COFFEE BUG (Antestia) BAIT (7)

Sodium arsenite	½ oz.
Sugar	5 oz.
Water	3 gallons

Use a good quality arsenite and weigh out accurately. Dissolve with the sugar in the correct amount of water. Apply with a fine "mist" sprayer, a small quantity only to each coffee bush. This spray is useful in controlling green stink-bug on beans and similar insects.

FRUIT FLY BAIT (8)

Lead arsenate	1½ oz.
Sugar	2½ lb.
Water	4 gallons

Dissolve the sugar in the water. Make the arsenate of lead into a smooth cream with a little water and then add to the sugar solution. Stir well. Use a garden syringe and apply the bait to the foilage like rain-drops. Apply weekly or after rain, starting a month before the fruit will ripen.

CUCURBIT FLY BAIT (9)

Sodium fluosilicate	1 oz.
Sugar	2 lb.
Water	4 gallons

Spray marrows, melons, etc., weekly after the fruit begins to set, using a garden syringe. The spray should fall on the plants in droplets.

HOUSEFLY BAIT (10)

Sodium arsenite	2 oz.
Sugar	2 lb.
Water	4 gallons

Mix thoroughly and then dip into the solution bunches of twigs and dried grass, which are then hung up in buildings where flies are troublesome. Care should be taken that the solution does not drip on to foodstuffs, utensils or live stock. This is a much cheaper method of controlling flies in draughty buildings than spraying with pyrethrum extract.

SUGAR-ANT BAIT (11)

Paris green	½ oz.
Sugar	8 oz.

Place poison and sugar (white) in a jar and shake until the crystals of sugar are evenly coated with green. Apply the mixture lightly to shelves and on the floor around cracks through which the ants enter.

LEAD ARSENATE SPRAY (12)

Lead arsenate	2 oz.
Water	4 gallons

Mix the lead arsenate to a smooth cream with a little water and then stir into the remainder of the water. Satisfactory results are not as a rule obtained with this spray unless a sticker is added to help the lead arsenate to adhere evenly on the foliage. For this purpose substitute one gallon of skim milk for one gallon of water, add 2 oz. acacia gum previously dissolved in a pint of the water by heating, or add 2 oz. soap (preferably soft) according to whatever is available. Spraying requires to be repeated after rain.

NICOTINE SPRAY (13)

Nicotine sulphate 40	1 oz.
Soap	4 oz.
Water	4 gallons

First dissolve the soap and then add the nicotine sulphate. Apply with a fairly fine spray, remembering that the insects have to be hit.

TOBACCO WASH (14)

Native tobacco	2 to 3 lb.
Soap	2 oz.
Water	4 gallons

Soak the tobacco in water for 24 hours. Strain and make up the solution to four gallons with water in which the soap has been dissolved. This spray should be used as soon as possible as the nicotine is soon lost.

DERRIS WASH (15)

Derris root	4 oz.
Water	4 gallons
Soap	2 oz.

Pound the root to a pulp under water, then strain. Make up the milky fluid to four gallons and add the soap. Use the wash right away as it will decompose on standing.

TEPHROSIA WASH (16)

Tephrosia leaves	6 oz.
Water	4 gallons
Soap	2 oz.

Us the fresh leaves of the fish poison or "utupa", *Tephrosia vogelii.* Boil in the water for thirty minutes, strain and add the soap. Use the same day.

PARAFFIN EMULSION (17)

Paraffin	2 gallons
Soap	½ lb.
Water	1 gallon

Heat the water almost to boiling and add the soap, which has been shredded, stirring until dissolved. Remove the vessel away from the fire and then add the paraffin, little by little, agitating vigorously with a stick or preferably

by pumping through a garden syringe. The success of this spray depends on complete emulsification of the paraffin in the soap solution at this stage. A thick white cream should be obtained which does not separate out into layers on standing. For use take:—

Stock emulsion ..	2 to 3 pints
Water	4 gallons

VEGETABLE OIL EMULSION (18)

Vegetable oil	1 pint
Soap	2 lb.
Water	2 gallons

This spray may be made with sesame, cotton-seed, groundnut or castor oils. The preparation is similar to that given in No. 17. For use take:—

Stock emulsion ..	½ gallon
Water	2½ gallons

VEGETABLE OIL EMULSION (19)

Oil	4 pints
Oleic acid	3 pints
Ammonia	2 pints
Water	4 gallons

Mix the ammonia and water together in a large vessel. Mix the oil (sesame, cotton-seed, groundnut or castor) and the oleic acid (commercial quality) together and then add slowly to the ammonia solution, with constant stirring. By this method an emulsion is formed with much less trouble than when soap is used, and it is therefore to be preferred when large quantities of spray are needed.

For use take:—

Stock emulsion ..	1 gallon
Water	10 gallons

CARBON BISULPHIDE FUMIGATION (20)

Carbon bisulphide is used to destroy insect pests in stored seeds, grains, foodstuffs, etc. The dosage required depends on the tightness of the room or container in which the fumigation is carried out, e.g.:—

Gas-tight chamber—5 lb. per 1,000 cubic feet space.
Reasonably tight room—8 lb. per 1,000 cubic feet space.
Tarpaulin cover—10 lb. per 1,000 cubic feet space.

At temperatures usual in East Africa, exposure for 24 hours is adequate, though with the possible exception of seed beans longer exposure is not harmful. Care should be taken to avoid flames or sparks coming in contact with the explosive carbon bisulphide vapour. One gallon of carbon bisulphide weighs 10½ lb.

PETROL FUMIGATION (21)

For the fumigation of small quantities of seeds, as well as the treatment of clothing and furnishings attacked by "moth", petrol is effective. Owing to the lightness of petrol vapour the dose should be introduced into the bottom of the container and care taken that the lid or cover fits tightly.

Dosage:—

1 pint per 25 cubic feet of space, i.e. ¼ pint in a 40-gallon oil drum.

PYRETHRUM SPRAY (22)

Pyrethrum powder ..	1 lb.
Paraffin	1 gallon
Diesel oil	1 gallon
Sesame oil	4 oz.

Soak the pyrethrum powder in the paraffin for at least 30 hours, then strain and make up the extract with more paraffin to one gallon. Add the diesel oil and sesame oil and stir. This spray is suitable for spraying the walls of grain stores, barns and other places liable to harbour storage pests, huts infested with bed bugs, and as a fly-spray in byres. It is not suitable for household use as it is liable to stain fabrics.

PYRETHRUM DUST (23)

Pyrethrum powder (fine)	1 part
Inert powder	2 parts

The intimate mixture of an inert diluent with pyrethrum powder is a great economy, since it is difficult in practice to distribute undiluted pyrethrum powder lightly enough. Diatomite, charcoal and lime are diluents which have been used. The main point is to choose an inert powder which can be obtained sufficiently fine as cheaply as possible.

COCKROACH POISON (24)

Sodium fluoride ..	4 parts
Pyrethrum powder ..	1 part

Mix well together and sprinkle on floors and shelves where it will come in contact with the cockroaches. Sodium fluoride alone is effective, but slow in producing results. The addition of pyrethrum powder hastens the visible effect. The mixture should be allowed to stay in place three or four days, and fresh powder put down at fortnightly intervals until the insects are cleared away.

Suggested remedies for common insect pests.—

Insect or group of insects	*Number of recipe*
Antestia (coffee bug)	(7), (23)
Aphis (greenfly or blackfly) ..	(13), (14), 15(), (16), (17)
Bean bug (green stinkbug)	(7), (23)
Caterpillars	(12), (13), (18), (23)
Cockroaches	(24)
Cucurbit flies (melon fly, etc.)	(9)
Cutworms	(1), (2), (3)
Fruit flies	(8)
Grain weevils	(20), (21), (22)
Grasshoppers	(4), (5)
Harvester termites	(6)
Houseflies	(10)
Leaf beetles	(12), (23)
Locusts	(5)
Mealy-bugs	(17), (18), (19)
Scale insects	(17), (18), (19)
Sugar ants	(11)
Thrips	(13), (14), (15), (16), (17), (18)

(*Received for publication on 15th October*, 1943)

RICE CULTIVATION IN HANGING SWAMPS

In the Mumias area of the North Kavirondo District of Kenya rice has been grown on a comparatively small scale for many years. Seed was probably originally brought from the coast by the Swahili and Arab slave traders before the advent of the white man, and planted by those traders who eventually settled in the area. Later planting of rice has been continued by the indigenous population who are largely Muslims.

The system of cultivation employed appeared easily applicable to large areas of otherwise practically useless land in North Kavirondo District, and for some years extension of the crop has been actively encouraged by the Agricultural Department. This has resulted in an increase in the quantity of paddy rice exported, from 50 to 100 tons per annum in the pre-war years to over 1,000 tons in 1943. It is probable that at least 25,000 bags (1,900 tons) could be produced in this district, and with the present increase in the cash return for the grower the crop is extremely popular in suitable areas.

As it is felt the system might easily be adopted in other areas of East Africa, a brief description of the method of cultivation is given below.

The type of land chosen is the gently sloping valleys running down to the many rivers and streams in the district, where seepage occurs owing to hardpans below the surface. Such land is useless for any other form of cultivation, but is used to some extent as dry-weather grazing. Normally the land supports no bushes or trees except, perhaps, the occasional small clump around an old ant hill. The grasses are of the ordinary swamp type, tussocky and very coarse. Soils vary from typical black swamp soils to those of a much sandier nature, the former naturally being the more suitable for rice cultivation. It is often necessary to burn off the large bulk of vegetation cover before ploughing can be carried out satisfactorily.

The long rains break in this part of the country in March, and if the year is normal this is the main planting month for cereal crops, with the exception of rice. December, January and February are normally fairly dry, but a certain quantity of eleusine and sorghum may be planted in February if sufficient rain falls. New land for rice should be ploughed or dug by hand as soon as the hanging swamps on the long sloping river valleys are sufficiently dry after the August rains, that is in late September or October. The land is then left for several months to allow the large amount of organic material to rot under the furrow slice. Preferably in December, but very often in January, that is in the middle of the dry season, the rice seed is broadcast by hand on the land which probably by this time has some weed cover. The weeds are removed by hoeing and in the same operation the seed is buried. The soil, though apparently fairly dry on the surface, generally possesses sufficient subsoil moisture to germinate the seed, but if not the seed will lie in the soil until the first light showers. By the end of February the young rice is some inches high and the first cultivation can be given before the long rains break and weed growth becomes heavy.

Generally two weedings are sufficient, but if the swamps become very wet some difficulty in killing the weeds may be experienced and a third hoeing may be necessary. The crop ripens in June and harvesting commences in that month. Harvesting is normally carried out by cutting each individual ear with three inches of straw. This method is tedious and some of the larger native cultivators have now been advised to cut the crop with a sickle or other suitable implement.

The three types of rices grown are known locally as Sindano, Mbuyi and Bungala, the last-named producing the best quality rice, but its cultivation is not popular with the growers. These varieties are not true swamp rices nor can they be considered hill types. In this district the altitude in the rice-growing areas varies from 3,800 to 5,000 feet, but it is probable that the above varieties would be suitable elsewhere at lower elevations.

The above method is described as at the present time, when rice cultivation in East Africa is receiving considerable attention, all methods of quick extension of the crop should be investigated. It is obvious that by avoiding the use of nurseries and seed-beds much supervision and education of the growers is obviated. Although the average yield of five bags per acre is low in comparison with those obtained in the rice-growing countries of the Far East, the cash return to the grower has proved sufficiently attractive and compares very favourably with that of other crops. With care, yields of 8–10 bags per acre are comparatively easily obtained.

(Received for publication on 1st November, 1943)

LAND PLANNING: THE UTHWATT REPORT

By V. Liversage, B.Sc. (Lond.), M.S. (Wis.), N.D.A., Agricultural Economist, Department of Agriculture, Kenya

To those interested in the planning of Africa for future needs the conclusions of the Uthwatt Committee will be of considerable interest as clarifying certain questions of principle and procedure. The Committee was appointed by the Minister of Works and Planning in 1941 to make an objective analysis of the subject of payment of compensation and of "recovery of betterment" in respect of public control of land-use and to advise on immediate steps which should be taken to stabilize the value of land required for development and to enable such land to be acquired by the public on an equitable basis.

The task of the Committee bore reference to the position in England where extensive re-planning under public control or actually by public enterprise will be necessary. The extent to which their conclusions are of interest to those concerned with African development hinges largely on the prospects of future industrial and residential development. However, questions of public control over the use of non-urban as well as urban land crop up from time to time, and the principles accepted by the Committee are of importance as indicating the trend of informed opinion in Britain.

The first principle on which the Committee take their stand is that the public has a direct interest in the use which is made of private land, and that, so far as land is concerned, a man cannot be allowed to "do what he likes with his own". "Fundamentally the problem arises from the existing legal position with regard to the use of land, which attempts largely to preserve in a highly developed economy the purely individualistic approach to land ownership. That was perhaps inevitable in the early days of industrialization and limited facilities of communication, but it is no longer completely tenable in our present stage of development and it operates to prevent the proper and effective utilization of our limited natural resources. Town and country planning is not an end in itself; it is the instrument by which to secure that the best use is made of the available land in the interests of the community as a whole. By nature it cannot be static. It must advance with the condition of the society it is designed to serve."

"Ownership of land involves duties to the community as well as rights in the individual owner. It may involve complete surrender of the land to the State or it may involve submission to a limitation of rights of user of the land without surrender of ownership being required."

No attempt is made to justify interference with property rights by resort to history and legal theory. No reference is made to the derivation of freehold from feudal tenure, with its theoretical restrictions. Nor is there any resort to the argument that property rights must proceed either from the ability of the holder to maintain his position against all comers or from the grant of the State. Certain legal precedents are quoted, such as the Housing, Town Planning, etc., Act, 1909, which modified the freedom of a landowner to develop his land in any way he pleased, and the general principle of "eminent domain" (right of re-entry by the State for public purposes), but in general, the Committee proceed on the assumption that planning is necessary and cannot be done without interference with private property rights. *Salus populi est suprema lex.*

Two kinds of interference with property rights are recognized, however, which fall to be treated in fundamentally different ways. On the one hand there is the acquisition of property by the State, with extinction of the former owner's interest therein. On the other there is the placing on the owner of an obligation to use the land in a particular way, or to refrain from using it in particular ways, in the public interest.

In regard to the first, claim to compensation is recognized at common law, though the basis of compensation rests with the State to prescribe. In regard to the second no claim for compensation lies at common law. "For the last hundred years owners of property have been compelled to an increasing extent, without compensation, to comply with certain requirements regarding their property, such, for example, as maintaining or improving its sanitary equipment, observing certain standards of construction, providing adequate air space around buildings and streets of sufficient width. The underlying reason for such provision is obviously, that compliance with certain requirements is essential in the interests of the community and that accordingly the private owner should be compelled to comply with them even at cost to himself". As it was put in a judgment by Wright, J. (now Lord Wright)

in 1927 "A subject cannot at common law claim compensation merely because he obeys a lawful order of the State". Some restrictions are necessary "in order that other people should not be injured in the legitimate enjoyment of their own rights. The principle is at its lowest that of 'live and let live' and advances so as to comprehend all the obligations which according to the social standards of the day are regarded as due to neighbours and fellow citizens."

"But as the scope of these restrictions increases by the operation of planning, a stage is reached at which the restrictions imposed will be said to go beyond the claims of 'good neighbourliness' and general considerations of regional and national planning require so great a restriction on the landowner's use of his land as to amount to a taking away from him of a proprietary interest in the land. When this point has been reached the landowner will claim to be fairly entitled to compensation, such compensation to be computed upon the principles applicable where other rights of property are taken away from him."

"At what point does the public interest become such that a private individual ought to be called on to comply, at his own cost, with a restriction or requirement designed to secure that public interest?" the Committee ask. The history of the matter has been, they observe "to push that point progressively further on and to add to the list of requirements considered to be essential to the well-being of the community". It "has passed beyond the field of health and safety to that of convenience and amenity".

The second principle upon which the Committee proceed is that accretions to land values due to the activities and general progress of the community—the "unearned increment" of the single-tax school—is not a proper subject for private profit. There are two elements concerned. On the one hand there is increase of value of particular properties due to local or central government action, such as extension of a road or water system; this is spoken of as "betterment" and it has been generally accepted that this may be fairly recovered in one way or another. On the other hand there is "the part played in increasing the value of property by general community influences such as the natural growth of population in the locality. The enhancement of value from this cause does not differ in principle from 'betterment' . . . and the right of the public to secure at least some part of it cannot be disputed."

At the same time it is recognized that hardship would be involved if "unearned increments" already accrued were acquired by the State without compensation. Many transactions may have taken place already in which the present prospects have been taken into account. Accordingly it is proposed to confiscate only future increments in value and to buy out present values where necessary. The development rights on undeveloped land are to be bought outright, in one transaction for the whole country. This method is not to be applied to developed land; in this case future increments of value are to be secured by means of a levy on the increment in the annual value.

Potential development value is divided into floating value and shifting value.

Floating value is the speculative value attaching to land by reason of the possibility that it may be required for development. "The hoped-for development may take place on the particular land in question or it may take place elsewhere; it may come within five years or it may be twenty-five years before the turn of the particular piece of land to be built on arrives."

Shifting value is caused by public control over land use. "If, for example, part of the land on the fringe of a town is taken out of the market for building purposes by the prohibition of development on it, the potential building value is merely shifted to other land, and aggregate values are not substantially affected, if at all."

The difficulty which has faced local planning authorities in Britain is that each owner receives compensation for the loss of the probability of development settling on his particular land, and the sum of the probabilities so valued greatly exceeds the actual possibilities, because in fact the development will not settle on all the land, and certainly not on all the land at the same time. If some land is taken out of the development market the owner is paid for loss of development value, but this value immediately settles on other land, and if development goes on falls to be paid over again.

It is clear that duplication of values would be eliminated if all the land were under one ownership. The Committee examined possible methods of bringing this about. They rule out land nationalization on grounds of expediency. It would arouse too much political controversy, would involve financial operations which might be out of the question, and would necessitate complicated administrative machinery to deal with the land of the whole country. The conse-

quence would be to delay the progress of planning.

Similarly, private pooling schemes are ruled out, as the logical conclusion would be one pool for the whole country, and since public control would be necessary the end would be indistinguishable from nationalization.

A method which was examined but not made the subject of a definite recommendation was the "unification of the reversion" on all land, i.e. the conversion of freehold to long leasehold interests, reverting to the State on expiry of the leases. The present value of a sum due at some time in the future is less than that at maturity by an amount which varies with the length of time and the rate of interest. Discounting at simple interest, the effect is that at an interest rate of 5 per cent a prospective value realizable 20 years hence is reduced to practically nothing at the present time, the corresponding period at 6 per cent being 16.6 years, at 4 per cent 25 years, and so on. A proposal was submitted to the Committee that all land should be "converted into leasehold interests held by the present proprietors as lessees of the State at a peppercorn rental for such a uniform term of years as may be regarded as equitable, and subject to such conditions enforceable by re-entry as may from time to time be applicable under planning schemes". The Committee observed that leases so created would be on all fours with leases of land for development under their own proposals. No compensation would be paid at the outset, and the term of years to be fixed would be such that the market value of the leasehold on creation would not be appreciably less than that of the freehold. They suggest the conventional term of 99 years.

The basis of the proposal is that the State would be acquiring for the future rights which at present are, mathematically speaking, worth nothing. The proposal to enforce conditions during the period of the lease, however, brought objections from two of the members. They considered that it would open the way to imposing burdensome conditions on present owners, resulting in forfeiture if they were not complied with, and would produce uncertainty leading to serious depreciation of land values. One member objected to it on the ground that it was tantamount to land nationalization. Other members, while realizing that a long time would have to elapse before the proposal could make any appreciable contribution to planning problems "hold it to be the task of this generation to take stock of the possible needs and views of succeeding generations with respect to National Planning. They wish to start time running in favour of succeeding generations." The proposal was recommended to the consideration of Government, with the remark that if adopted it would not interfere with their other proposals.

The scheme recommended for immediate adoption is that the State buy all development rights outright in consideration of fair compensation. The land itself would remain in the hands of its present owners, but shorn of its development rights. If required for development subsequently it would be taken over by the State at undeveloped value and leased to the party proposing to undertake the development. Mortgages and other incidents would remain attached to the "owner's interest".

The development rights are to be valued not by taking each property in turn and thus multiplying the total value, but by assessing the global net value. This is to be done by taking into consideration the rate of development in the past and estimating the rate in the future after allowing for various factors such as the war, rising standard of living, trend of population and so forth. Presumably future development values will be discounted according to the usual arithmetical formula. The total is then to be divided over the various properties in proportion to the individual development values of each, and paid out.

If, subsequently, land is required for development it will be purchased at the price of undeveloped land, the actual amount to be decided at the time of purchase in the ordinary way. Compensation for disturbance will also be paid to the owner, where appropriate. The land will then be placed at the disposal of the person or body who is going to undertake development, but the disposition will not take the form of outright grant of the freehold. It will take the form of a lease, subject to a rent or premium or both, for the period required by the nature of the development. The lease is to contain provisions to ensure that the land is being developed and used in accordance with the agreed proposals, and is to provide for a right of re-entry on breach of covenant.

In order to simplify the working of the scheme it is recommended that the provisions relating to undeveloped land shall be restricted to land outside the fully built-up areas of towns. In regard to the latter development values have already accrued and it will be simpler to acquire the freehold outright if and

when the land is required for planning purposes. The compensation payable in respect of sites acquired in built-up areas is to be assessed on the price receivable by a willing seller, but subject to the proviso that demand arising from the operations of public authorities will not be taken into account (one member of the Committee dissented from this proviso).

The future incremental value of land in built-up areas is to be secured to the State by means of a levy on increases in annual site value. Some of the incremental value will doubtless be due to expenditure by the individual site owner and in order to avoid the difficulty of attempting to allow for this in the assessments the levy is to be at the rate of 75 per cent only of the incremental value.

Such are the Committee's main recommendations. Space does not permit mention of the various modifications proposed to meet particular circumstances. One modification which must be noted, however, is that agricultural land is left outside the ambit of the whole scheme until it is required for some other form of development. Agricultural enterprise is not regarded as "development" for the purposes of the scheme. The interest of the Report for readers in Africa lies in its discussion of principles and attitudes towards land, though its contents are relevant to the matter of residential and industrial development generally.

(Received for publication on 29th October, 1943)

WATERPROOF WHITEWASH

By M. D. Graham, Agricultural Officer, Department of Agriculture, Kenya

Some years ago I came across the appended recipe in an agricultural journal, tried it and found it remarkably successful. It has since been used extensively on Bukura Agricultural Station for external work and has withstood our high rainfall and even severe hail, where the plaster is hard enough to resist pitting.

(*a*) Unslaked lime or lime oxide, 7½ lb.

(*b*) Rock salt, or cattle salt, 1½ lb.

(*c*) Cement, ¾ lb.

The method of preparation is: Dissolve the salt in one gallon of cold water. When completely dissolved pour on to the lime. Now add to the lime 1½ gallons of water, *slowly* allowing it to slake. Add the cement, by sprinkling on a little at a time when the lime is almost slaked. Stir thoroughly. It is advisable to use a trough-like receptacle for the preparation of this limewash, because terrific heat is generated during the slaking of the lime. The use of a narrow-mouthed mixing vessel can very easily result in a mild explosion caused by the steam, with probable serious burns to the operators.

It is highly important that, as soon as the lime has slaked, the wash should be applied *immediately and while still hot.* That is why the above proportions have been given as it has been found that one man can apply this volume before the last of it gets cold.

It will be found that the quantity of water given is by no means a constant. It depends on the quality of the lime used, some slaking quickly, some slowly, so that each type generates heat at a different rate. Thus, more or less water is lost as steam according to the quality or type of lime used. Rock forms slake slowly, but the powders are almost instantaneous. The ideal mixture should have the consistency of rather thick distemper. A little water may have to be added to the last gallon or so of mixture. Keep stirring constantly. It pays to have two people on the job, one to stir and prepare the batches of wash and one to apply it.

It is important to see that the surface to receive the whitewash is free of old, flaking lime or other washes. Part of the advantage of this wash is its power to penetrate the plaster, whether the latter is cement or lime. Thus a clean surface will ensure success.

For internal use this whitewash has also been most useful, because it can be washed, even scrubbed without coming off.

Of the many recipes for whitewash, this appears to be the only one, so far tried, that bears out its name and is certainly proof against rain, once it has set. It takes about two days to harden sufficiently to withstand heavy rain. For preference, just as with plasterwork, this whitewash should be applied, externally, during dull or misty weather, but it will be found that it will set and not flake, even if applied during dry, hot weather.

SCLEROTINIA DISEASE OF BEANS AND OTHER CROPS

By Maud M. Wallace, B.Sc. (Hons.), M.Sc. (Lond.), Temporary Scientific Assistant, Department of Agriculture, Tanganyika Territory

The outstanding points about this disease (*Sclerotinia sclerotiorum* (Lib.) de Bary) are as follows: it is capable of attacking a large number of crops and garden plants; it varies greatly in intensity from year to year, and under favourable conditions may reach epidemic proportions; there are a few precautions which can be taken to control it. These points are amplified in the following paragraphs.

The local history of Sclerotinia disease is given below. It has been known in most countries for many years, but in Tanganyika Territory it was not observed until 1942; there is little doubt that it had been present in previous years.

In June, 1942, the disease was observed in French beans on a farm at Mondul in the Northern Province, and immediate measures were taken to destroy the infective material. In June, 1943, the disease occurred in many fields of beans and in other plants at Machame on Kilimanjaro, and it was also observed in beans at Oldeani. A field of sunflower at Machame was heavily infected, and the loss by this disease was estimated at from 30 to 40 per cent of the crop. Tomato plants growing in a wild state, unsupported and trailing on the ground were also found affected at Machame. Potatoes suffered slightly through infection of the stems; this crop is known to be very susceptible in other countries, as in the west of Ireland where the loss due to this disease is only exceeded by that resulting from Late Blight.

Among flowering plants, Dahlia, Tropaeolum and Eschscholtzia were lightly affected at Machame. The number and variety of plants affected at the latter place indicate that only further investigation is required to demonstrate the presence of the disease in other areas. In Kenya, Sclerotinia disease was first observed in 1941. There, according to Dr. R. M. Nattrass, it attacks pyrethrum and other crops and ornamentals; the pyrethrum had also a second species of Sclerotinia, *S. minor*.

Symptoms of the Disease

While wilting and yellowing of the foliage occur some time after infection, diagnostic symptoms can be seen at an early stage. Hollow-stemmed plants are more susceptible than those with solid stems. The parts most affected are the stems, infection usually taking place at leaf-scars; in beans the pods are also susceptible, and in sunflower the seed-head. Affected parts of a plant soon turn soft and show a grey to brown colour with a water-soaked appearance. Leaves and pods or other parts beyond the points of infection ultimately wilt and dry up. The diseased areas are partly covered by a white mycelium, and amongst this there are formed at an early stage, black resting bodies known as sclerotia. These are round or oval and comparatively large; they have been seen up to $\frac{3}{8}$-inch long by $\frac{1}{4}$-inch wide; they are loosely attached and if superficial are readily knocked off. In hollow-stemmed plants such as sunflower sclerotia are produced abundantly within the stem, and reach the ground when the stem decays.

On sunflower heads an extraordinary large sclerotium is formed which covers part or the whole of the seed layer; it extends between the outer parts of the seeds and when removed it shows diamond-shaped spaces. The seeds below are soft, grey and usually hollow.

Life-history of the Parasite

The sclerotia referred to above reach the soil, and may remain dormant for months or even years. When a favourable season occurs the sclerotia, if not buried too deeply, germinate to send up slender stalks to the surface of the soil. The stalks bear pinkish-buff coloured cups or discs, up to 8 mm. in diameter. These are the spore-bearing organs (apothecia), from which vast quantities of spores are discharged into the air. When these spores are blown on to dead plant tissue, they germinate to produce a white mycelium which spreads over the surface; on a susceptible host-plant the mycelium penetrates the healthy tissue and in a short time the sclerotia are formed. In the laboratory sclerotia from bean pods, buried at one inch depth in a pot of soil and kept moist, produced apothecia in two and a half months.

Control

While the parasite is probably endemic in the soils of many areas, particularly in the moister climates of higher altitudes, an endeavour should be made to prevent infected plant material reaching the soil. It should be dried in heaps and burned. When diseased plants are removed from a growing crop, more space and air are given to the remainder.

In endemic areas the most important preventive measure is to avoid too close planting of susceptible crops, or interplanting with other crops; weeds should be kept down and adequate drainage provided. It may be advisable to sow resistant crops such as cereals or perennials. Deep cultivation after harvest will bury many sclerotia out of harm's way. In a season favourable to the disease, however, it is doubtful if much control will be obtained.

Other sclerotial parasites with which the Sclerotinia might be confused are distinguished as follows: Rhizoctonia species have black sclerotia, but these are very much smaller (pin-head size), and are usually found on the roots; in *Sclerotium rolfsii* the sclerotia resemble mustard seed in size, shape and colour, i.e. more or less round and brown.

(*Received for publication on 27th September*, 1943)

FOOD STANDARDS AND HUMAN HEALTH

Within the last generation science has given us a new body of exact knowledge about human and social needs. We now know, as men in earlier years did not know, something about basic requirements in food, housing and town planning, clothing, rest and education. We know more in some of these fields than others, and we have not got quite beyond the stage of controversy in any of them. But we are beginning to feel firmer ground under our feet than ever before: and we are beginning to appreciate that the area of firm ground will increase steadily, as scientific method is extended in the sphere of physics, chemistry, biology, psychology and the social sciences.

What is the character of this new scientific knowledge about human needs? It is at its most advanced, most exact and least controversial in the field of diet. Not all scientists are agreed about the correct standards. That would be asking too much of human nature. But within fairly narrow limits they do claim to know what diet is necessary to existence and—a different matter—for good health. Moreover, what the biologists have discovered in the laboratory has been grimly documented by the social scientists. They have told us that in Britain, one of the wealthiest communities in the world, nearly half the population a few years before the war had a diet below the minimum needed for health. We know also that startling results on the health of adults and the growth and health of children have followed on simple improvements in diet made under controlled conditions. Finally, the great experiment made possible by the war itself has demonstrated triumphantly that a people living on a diet more restricted in bulk and variety, living too in conditions of great strain and dislocation, can actually be healthier than before, when steps are taken to ensure that the food they do get contains the right proportions of those ingredients needed for healthy living. The scientists would be throwing up their hats over this resounding demonstration of the validity of their theories—if scientists did that sort of thing. Perhaps they will say that they leave it to the politicians!

But the improvement in national health during the war must not blind us to the fact that we are, partly through ignorance, partly through poverty, still well below an optimum food standard, and that health, growth and expectation of life would all be greatly improved if we could attain that standard.

If that is true of a community like our own, picture the gap that exists between fact and ideal in the world as a whole. Consider the implications of the fact that Africa and Asia, containing over 60 per cent of the population of the world, enjoy about 27 per cent of its supplies of cereals (including rice) and about 9 per cent. of its meat. The percentage figure for milk, if we had it, would be lower still.

I cannot do better than end these remarks about food standards with a sentence written by two scientists, Bacharach and Drummond: "If the whole of the human race, after making due allowance for any effects of different climatic and geographical conditions on maximum health, could by some stroke of the pen be possessed of, and persuaded to eat, a diet constructed on the lines indicated here, then the consequent change in human health, and the resultant change in human society, would be the profoundest that have ever occurred in the history of mankind".

Rt. Hon. Herbert Morrison, P.C., M.P., at the meeting of the British Association, September, 1941.

CULTIVATION OF PAPAW AND PRODUCTION OF PAPAIN

By F. R. Sanders, B.A., C.D.A., and J. K. Robertson, B.Sc. (Agric.), A.I.C.T.A.,
Department of Agriculture, Tanganyika Territory

Source

Papain is a product obtained from the papaw or papaya (*Carica papaya L*). Ceylon and adjacent countries are the most important producers of papain, although some is produced in the West Indies, particularly in Jamaica and Trinidad, while in recent years the production of this article has been taken up in Tanganyika, chiefly in the Northern Province. Much of the production from the West Indies was shipped to the United States, which in pre-war years also imported considerable quantities from Japan (26,000 lb. in 1939). The bulk of the papain produced in Ceylon is marketed in Europe.

Soils

Papaws grow best in rich loamy soils and in areas enjoying a good and well distributed rainfall. While a good rainfall is required, adequate drainage is absolutely essential, since the crop does not succeed in badly drained areas.

Planting

Seed required for establishing a papaw plantation should not be taken from fruits that have been tapped for papain. A few plants of suitable type should be set aside for seed production and properly marked to ensure that they are not tapped. So far little work has been done on the selection of types for papain production, although in Northern Province the long narrow-fruited type is preferred to round-fruited types.

Seed may be sown in the nursery or planted in the field at stake. If nursery practice is followed the seedlings are planted out in the field when they have attained the height of 6 in., ball planting being the most satisfactory method. Plants up to a height of 2 ft. can be transplanted perfectly well, but such tall plants are easily damaged by wind at ground level, resulting in the entry of fungi and the collapse of the plant by stem rot. Three seedlings are generally planted at each "stake" and the plants later reduced to one as soon as sex is determinable.

Where seed is sown direct in the field several seeds are planted at each hole, the most vigorous seedlings are selected and their number reduced to one later. All male plants in excess of one in fifty are removed as soon as sex can be determined.

Planting distance is generally 8 ft. by 8 ft.

Cultivation

The plantations are kept clean weeded, but in some cases catch-crops of beans are grown between the papaws. In the Northern Province papaws interplanted in growing coffee have not shown satisfactory growth, although slightly better results have been obtained where the coffee trees have been stumped prior to planting the papaws. Experience at present indicates that papaws are best grown as a pure crop and that any other crops grown on the same land are best confined to short-term annuals such as beans (*Phaseolus vulgaris*).

Tapping

Papaws begin to form fruits roughly six months after planting out in the fields; tapping can commence when the fruits have attained a diameter of four inches, i.e. tapping should be well under way before the plants are one year old. In the warmer parts of the Northern Province tapping has commenced at 7-8 months from planting out. Tapping is best done in cloudy weather or early in the morning and in Ceylon is always completed before 10 a.m., since the yield of latex is considerably reduced when tapping is done under hot conditons. The yield of latex during the hot dry season is so low that tapping is generally limited in practice to a period of nine months per annum, and at the end of this tapping period all fruits which have been tapped are removed.

Latex yield appears to be largely dependent on soil moisture, dry conditions causing a diminished flow. It is also dependent on the length of time over which tapping has been done; for example, one area in its ninth month of tapping will give little latex, while an adjacent area in its fourth month of tapping is still giving a high yield. Present indications in the Northern Province are that tapping cannot be continuous throughout the year.

Although some plantations only tap the larger fruits, others bleed fruit of any size that will yield latex; the effect, detrimental or

otherwise, is largely a matter of opinion. On plantations where this latter method has been employed the yields have not fallen off as yet. Whether the yields will be maintained if the practice is continued is a matter to be determined by experience. With the present high prices, hard tapping, with due insurance of fresh areas coming into bearing, is possibly the best policy.

The fruit is tapped with various types of blades, razor blades being mainly used. Experience in Tanganyika is that the colour of the latex is not affected by contact with these blades. The blades are embedded in hard rubber and should not protrude more than one-eighth of an inch, since deeper incisions are conducive to the entry of fungi and the destruction of the fruit by fungal growth. The piece of rubber with the blade embedded in it is normally tied to a stick. Three to four longitudinal incisions are made in each fruit and subsequent tappings are made between the previous incisions.

Tapping is done at intervals of approximately ten days. The latex is collected on cloth of *americani* type stretched over an iron frame which is clamped to the tree. Great care is taken that the latex does not come in contact with the iron frame, otherwise the latex will be discoloured.

When bleeding of the fruits at any one tapping is complete the latex is scraped off the cloth frames into small covered wooden boxes. Great care must be taken at this stage that the latex does not come in contact with the hands or fingers. All latex which has coagulated on the fruit is wiped off and is not mixed with latex on the *americani* collecting cloth.

Processing

The latex so collected is returned to the factory as early as possible after the end of each tapping and there should be no delay in completing the drying. If delay between collection and drying of the latex is unavoidable a 1 per cent solution of formaldehyde may be added to the latex to prevent putrefaction. It is worthy of note, however, that samples of latex to which formaldehyde had been added showed a slight reduction of enzyme activity as the following figures by the Government Analyst prove:—

Sample	*Enzyme activity* *
No. 1—1 per cent of formaldehyde added to sample No. 3.. ..	19
No. 2—Early tapping	22
No. 3—Late tapping	22

* Grams of albumen digested by 1 gram of papain.

While the enzyme activity of sample No. 1 is less than that of the other samples, all are above the B.P. codex minimum of 16.

On arrival at the factory as much extraneous matter as possible is removed and the coagulated mass is pressed through a fine copper or brass gauze of 45–50 mesh in order to remove the last of the extraneous matter. The coagulated latex is then spread out on white cloths which are spread on trays and placed in the drying kilns.

Various types of kilns are employed, the most successful being entirely enclosed and consisting of trays arranged in tiers over flumes. The time required for drying is roughly twelve to fourteen hours and the temperature during drying should not exceed 100°F.

The dried product should be creamy white, crumbly, and free from all extraneous matter. Pulverized papain is not acceptable on the market at present, although pulverization gives a better colour to a sample originally of poor colour. Sun-drying gives a darker article than kiln-drying and is seldom used by large producers. The yield of the dried product in Tanganyika is 60–100 lb. per acre per annum.

Packing

In Tanganyika up to now papain has been packed in empty 4-gallon petrol tins which are preferably lined with paraffin. The tins are exported in the usual petrol cases. After the tins have been filled with papain it is preferable to extract the air before the tins are sealed. Papain should not be exposed to strong light for any length of time, otherwise discoloration is bound to occur.

Present prices, which show a marked rise above pre-war, are roughly Sh. 9 to Sh. 10 per lb. f.o.r. The material is used as a tenderizer of meats and in recent years has been widely used for degumming silk (i.e. silk produced by silkworms), especially where this is associated in fabrics with rayon (artificial silk) and wool, since the materials previously used for degumming silk had a deleterious effect on rayon and wool. A method has also been patented wherein papain is used to prevent felting shrinkage in wool fabrics.

Received for publication on 21st September, 1943

DISEASES OF PAPAWS

By G. B. Wallace, B.Sc., Ph.D., Plant Pathologist, Tanganyika

(1) A Root, Stem and Fruit Rot of Papaws

A disease of papaw trees has recently been found on a few estates in the Northern Province of Tanganyika Territory. It can cause a certain amount of damage to individual fruits and can also kill seedlings or mature trees. As a rule only a comparatively small number of trees are killed and the cumulative amount of loss may not at once be appreciated. A full investigation has not yet been undertaken, but this preliminary note will indicate the nature of the disease and measures which will enable considerable control to be effected.

The cause of the disease is a Pythiaceous fungus, a species of either *Pythium* or *Phytophthora,* or more likely more than one species. A species of the former has been recorded in Uganda. In South Africa five species of *Pythium* have been isolated by Wager [1] from diseased papaw trees at different times, while elsewhere another *Pythium* and a *Phytophthora* have been isolated. (A later publication by Wager is not at present available.) The majority of these fungi are capable of causing disease in other species of plants also.

Symptoms of the disease

The local experience of the disease is as follows:—In seedlings 20 per cent of the plants in a large field on Kilimanjaro were affected by a pythiaceous fungus in June–July, 1943. The effect was a damping-off or foot rot. The seed had been planted at stake. The roots appeared healthy, but dark "water-soaked" lines were seen running up the stems. Older seedlings were shrunken, dried and flattened, and had wilting leaves.

In older trees the fungus can attack the roots and collar, and has been seen in these parts, but the great majority of infections have been noticed in the upper parts of the tree. The fungus as a rule enters at the scars left by fallen leaves, flowers or fruits. If it enters an old leaf-scar below the existing foliage, it spreads across a section of the stem, causing it to rot; the part above falls over, leaving only the bare stem standing, which may, however, send out new shoots from below. If the fungus enters a scar among the leaves and fruits it penetrates that part of the stem and then spreads to the leaf-stalks or the fruits, causing these to fall. Many fallen fruits show the rot and frequently a thin but dense grey-white layer of fungus mycelium and sporing bodies; most infections of fallen fruit appear to arise after their fall from the tree. It is important to note that they form an ideal breeding ground for the parasite.

Some papaw trees show the collar and the upper roots to be soft and rotten. Such infections are usual in the case of the disease in South Africa, where it is known as "Foot-rot". Attention is called to such trees by the wilting and yellowing of the foliage, and later by the fall of leaves. Wager gives further symptoms in trees with Foot-rot: "The newly-formed leaves are smaller than normal and have much shorter petioles. The fruits are smaller than normal, and the majority of the flowers do not set, but fall off. As the disease progresses, only a small bunch of leaves is left at the apex of the trunk. Later on, the tree becomes entirely defoliated". Such trees can be blown over or readily pushed over.

Cause of the disease

The causative fungus has not yet been isolated in pure culture; that will be necessary before its identity can be ascertained. The importance of the name is that it will indicate other potential host plants of the parasite. In the meantime the general control measures are the same whatever the species.

Control measures

In South Africa the predisposing causes of the common Foot-rot form of the disease have been found to lie in adverse soil conditions or in faults in cultivation, e.g. waterlogging, injury of the roots by hoes, etc. In the case of the disease in seed-beds, excess moisture and close sowing are known to encourage damping-off by the same fungi. The preventive measures are, clearly, to provide good growing conditions and to avoid injuries, and in seed-beds found affected to sterilize the soil with Cheshunt compound in subsequent sowings and to sow thinly.

Cheshunt compound is prepared as follows: Grind separately to fine powders 2 oz. copper sulphate and 11 oz. ammonium carbonate. These are then thoroughly mixed dry and stored for at least 24 hours in a tightly stoppered glass or stone jar. For use, dissolve 1 oz. of the mixture in a little hot water, then make up to 2 gallons with cold water.

In the field where seed or seedlings are to be planted, the ground should be carefully weeded and cultivated on the sites of the hills, to ensure good aeration and to enable the young plants to make quick and strong growth. If the land is flat and liable to prolonged saturation, planting should be done on low hills. Care should be taken not to injure the roots in subsequent cultivation as this simplifies entry of the fungus. Should infections be found, the affected plants should be removed and the soil of these hills watered with Cheshunt compound (see above).

Where the upper parts of the trees are the parts affected, the most important control measure is field sanitation—that is the elimination of infective material such as dead trees, over-ripe or diseased fruit on the trees and all fallen fruit from which the spores of the parasite can be spread to healthy trees and fruit by wind and probably also by fruit-flies. Dead trees, or trees with foot-rot, should be dug out, dried and burned. Allow an interval before replanting in the same holes.

Where, as was seen in one case, a papaw field adjoins the overgrown banks of a river, and the atmosphere is moist, a clear uncultivated area should intervene to allow more movement of air and make the air drier.

(2) Other Diseases

Certain other diseases are common and widespread in papaws. Mildew (*Ovulariopsis papayæ*) is probably the most common, but is not usually serious. Sulphur dusting is suggested for control if that is necessary.

Anthracnose (*Colletotrichum gloeosporioides*) can be troublesome in fruit left on the trees beyond a certain degree of ripeness. Old fruit and leaf-stalks lying on the ground can be a source of future infection and should therefore be destroyed or buried.

In Kenya, Nattrass has recorded [2] fruit rots caused by *Gloeosporium* and *Ascochyta caricæ*, in addition to *Colletotrichum*. The *Ascochyta* is of interest in that it has been recorded as very destructive elsewhere; in Queensland, for example, Simmonds has stated [3] that it is probably the most serious disease to which papaws are subject in that country; there it is known as Black Spot. It affects all the above-ground parts of the plant, with the exception of the leaves; in this respect it recalls Pythiaceous rots, but can be distinguished by the characteristic black colour it produces and the presence of tiny pustules from which white tendrils of spores emerge.

Control measures recommended by Simmonds for Black Spot are as follows. Cold exposed sites should be avoided, and vigorous growth should be encouraged by manuring; potash is beneficial to fruit formation. Dead leaf stalks should be collected and burned. Where stem-rot is present, the plants should be cut across below the point of injury, if possible at one of the stem partitions, to encourage a new stem; this should not, however, be done in wet weather.

REFERENCES

[1] Wager, V. A.—*Science Bulletin No.* 105, Dept. Agric. Pretoria, 1931.

[2] Nattrass, R. M.—*East African Agric. Journ.* VII, 1, 1941, p. 57.

[3] Simmonds, J. H.—Diseases of Papaw, *Pamphlet No.* 41, Dept. Agric. and Stock, Queensland, 1937.

(*Received for publication on* 21*st September*, 1943)

ELECTRIC FENCING

Much interest has been taken in electric fencing in Great Britain of recent years and there it is apparently a great success. (cf. the article in the Journal of the Ministry of Agriculture, England, for June, 1943). It may therefore be worth while to record that experience in East Africa is by no means so favourable. In particular the Agricultural Officer, Kitale, writes:—

"Electric fencing has been used successfully for mature cattle on this station, which had previously been accustomed to being in fenced paddocks. For young stock and for stock unused to fencing it was of little use. As regards general notes on erection, it was found essential to use barbed wire rather than plain, as the hair of cattle acts as an insulator and no shock is received with plain wire. Great care must also be taken to ensure proper insulation, and the use of gates should be avoided on account of the difficulty in obtaining proper contact through the gate."

The Agricultural Officer, Rumuruti, comments:—

"One or two farmers have used it for cattle, but from what I have seen of this type of fencing I would not care to recommend it in game-infested areas."

NOTES ON ANIMAL DISEASES

XXI—DISEASES CAUSED BY WORMS

Compiled by the Veterinary Department, Kabete, Kenya

Classification

The more important parasitic worms belong to three phyla, the flatworms (Platyhelminthes), round-worms (Nemathelminthes) and ringed worms (Annelida). The parasitic flatworms are the flukes (class Trematoda) and the tapeworms (class Cestoda). The parasitic round-worms of domestic animals in Kenya are all members of the class Nematoda and the only parasitic annelids are the leeches (class Hirudinea). Before detailing the more important parasitic worms of stock, a few brief notes on the causes and diagnosis of worm infestations will enable the reader to obtain a better appreciation of the problem and will avoid much repetition.

Causes of worm infestation

The majority of worms do not produce symptoms unless present in large numbers and the fact that animals suffer from worms at all is less the fault of these parasites than of the disturbance of the host caused by domestication. The zebra and the guinea fowl are examples of wild animals which are always packed with worms and which appear to keep excellent condition. Under natural conditions, however, animals are free to migrate and hence, except perhaps during very severe droughts, they are able to maintain themselves on the diet for which they became evolved. Once an animal is tamed, its environment is unnatural and restricted, and its diet may be very different from that for which it is fitted anatomically and physiologically.

In the free state, moreover, the energy derived from the food is expended on the maintenance of the animal and on reproduction at a rate suitable for the species. Domesticated animals, however, have to spend additional energy on work, either on mechanical work, such as that of work-oxen or riding-ponies, or on production, for example, of wool, milk or eggs. The supply of energy is limited by the functional capacity of the alimentary tract, and it is obvious, therefore, that waste through parasitism may upset the positive balance necessary for health. Most farmers see the necessity for feeding concentrates to race-horses and high-producing cows; few, however, realize that extra energy is also required to produce and carry a heavy Merino fleece.

Speaking generally, therefore, the reasons why domesticated animals suffer from the effects of worms are, firstly, heavy concentration of worms, and secondly, interference with the normal plane of nutrition. These points are important for they bear on methods of control.

Many instances could be cited of farmers who, having realized the advantages of keeping a small flock of sheep on their farms or a small number of poultry, have decided that running sheep or poultry is a simple and profitable proposition and have increased the numbers only to meet with disappointment. Losses in such cases are almost always attributable to worms and the explanation is usually easy to find. A small number of sheep or poultry around the homestead do not build up a heavy infestation of worm eggs or larvæ on the land; but when numbers are increased the land rapidly becomes fouled and special precautions must be taken if the stock are not to develop abnormally heavy worm burdens. The few sheep or poultry have ample choice of food: when many are present they may have to take whatever is available to satisfy their hunger. Restriction of choice, therefore, leads to disturbance of the nutritional plane. The reason for the disturbance may not be obvious. A patch of grazing, for example, may appear excellent to the human eye; but plants vary in their mineral and vitamin contents and it may happen that there are insufficient specimens of a certain type for all the animals to obtain their full requirements.

As sheep and poultry are farmed on a larger scale than other species, parasitic troubles are more frequent in them. The most important principle to observe is frequent movement. It is impossible to lay down any definite period after which a sheep *boma* should be moved. The safe time will obviously depend upon the number of sheep in the *boma,* the type of country and the season of the year, and it can be judged only by experience. Water supplies in East Africa are often difficult and it is sometimes the practice to move the sheep *boma* and grazing areas frequently, but to water the sheep at the same spot for a considerable period. Trampling causes the area around the watering place to become either soggy, if flat, or dry and bare, if sloping. In the former case, conditions ideal for the development and persistence of worm larvæ are produced, and in the latter the fouled earth is frequently treated as a salt lick. It is obviously desirable, therefore, to pay special attention to watering sites.

When keeping large numbers of poultry the runs should either be capable of being moved or should be sufficiently numerous to allow of two being empty whilst one is in use. The former method is to be preferred, since the intermediate stages of some poultry worms occur in earthworms and other burrowing animals which are not eradicated when the ground is dug over.

Diagnosis of worm infestation

Symptoms.—The symptoms produced by parasitic worms depend on the habitat of the worms and on the numbers present. In the vast majority of cases the presence of a few worms causes little or no disturbance; in fact it is exceedingly difficult to maintain stock completely free from worms.

Each species of worm has its own habitat and the commonest sites to find adult parasitic worms are the alimentary tract, the liver and the lungs. The lungworms are rarely found in domesticated animals in Kenya except in sheep, and as infestation of this species has already been described in these notes, there is no need to mention them further.

The symptoms of worm infestation of the alimentary tract vary slightly with the different kinds of worms and the species of host; but they consist usually of unthriftiness and loss of condition ("razor-back"), watery swelling of the throat ("bottle-neck") and fluid in the thoracic and abdominal cavities ("pot-belly"). The coat is usually rough or shows irregular patches and the skin may be "scurfy". There is almost always some degree of anæmia; but pallor of the mucous membranes is particularly marked when large numbers of blood-sucking worms, such as hookworms, are present. Many species of worms cause diarrhoea and the fæces may be dark rusty red in colour owing to the presence of digested blood.

Of the liver parasites, fluke is the only one to produce symptoms. The symptoms resemble those produced by blood-sucking strongyles in the alimentary tract.

Collection of worms.—Whilst the collection of parasites from sites other than the alimentary tract usually presents little difficulty, it is necessary to adopt the following method if a proper idea as to the numbers and species of forms present in the stomach and intestines is to be gained. It is recommended that all dead sheep be examined in this way as a routine, so that the farmer can keep himself informed as to the health of his flocks.

The method depends upon the greater specific gravity of worms when compared with that of the semi-digested food material in the guts, and is comparable to the process of panning for gold. Three large glass jars, for example battery jars, are taken. Into the first the contents of the stomach (in the case of ruminants, the fourth or true stomach) are squeezed. The stomach is then slit open along its length and the inner lining is washed with water which is added to the jar. The contents of the stomach are then broken up (if necessary) and the jar is filled with water. After standing for a few minutes to allow the worms to fall to the bottom, the overlying liquid is poured off, more water is added and the contents are thoroughly mixed. The jar is allowed to stand and the process repeated until the residue in the bottom consists almost entirely of worms.

The small intestine is stripped from the skirt and placed in the second jar. It is then opened from beginning to end with a pair of scissors, the hand holding the gut being placed so that the slit portion and contents fall back into the jar. The gut is pulled through the fingers so that the ingesta and any worms adhering to the mucous membrane are retained in the jar and is then examined for hæmorrhages and discarded. The contents of the jar are washed as in the case of the first jar, until the worms are almost free from extraneous matter.

The third jar is used similarly for the examination of the large intestine. Once the three jars are filled, the supernatant fluid can be poured off and fresh water added to each in turn, and in this way the whole process should not take more than one hour.

Once the worms are obtained reasonably free from ingesta small batches are poured into a shallow glass dish where they can be sorted and counted. If the method is followed carefully a reasonably accurate count of all but the smallest species can be made. A hand lens will be found useful for detecting small trichostrongyles of sheep.

Many attempts have been made to obtain an estimate of the numbers and species of worms in the alimentary tract of animals by counting the eggs present in the fæces. Unfortunately, no reliable method has been found. The numbers of eggs produced by the worms seems to vary from day to day and the close resemblance between the eggs of many species makes identification, unless cultural methods are used, impossible.

Flukes

Flukes are unsegmented parasitic flatworms with an alimentary tract. The majority are bisexual. The life history of the internally

parasitic forms is extraordinarily complicated. From the egg which leaves the definitive host a form known as a "miracidium" escapes. This swims about in water until it finds an appropriate host, usually a snail. It penetrates between the cells of the skin of the snail and continues until it reaches a particular organ, where it settles and begins to grow into a sac-like body called a sporocyst. Buds develop on the inner lining of the sporocyst and drop off into the centre where they form bodies called "rediæ". The posterior end of a redia is also sac-like and further rediæ may develop therein. Finally the rediæ produce bodies called "cercariæ" which escape from the snail into the water. These may be swallowed by the definitive host, or they may encyst on vegetation and become resistant to desiccation until such time as they are swallowed. In the case of blood flukes, the motile cercariæ are capable of passing through the intact skin.

Only three groups need be considered here, the liver flukes, paramphistome flukes and the blood flukes.

Liver flukes.—Liver fluke occur in sheep and cattle, being probably more common in Kenya in the latter species. These parasites are flat, elongated, leaf-like animals, brown-grey in colour, which when mature are found in the bile ducts of the liver. Eggs pass to the bowel by the bile duct and are passed out in the fæces. The intermediate host is *Limnæa natalensis,* a snail which favours stagnant water.

On post-mortem examination the bile duct walls are found to be greatly thickened and adjacent parts of the liver are pale in colour and fibrous. Cases of sudden death sometimes occur due to a sudden massive infection of sheep with fluke. In such cases death results from the extensive destruction of liver tissue by numbers of minute flukes or from infection of the damaged liver by a pathogenic anærobe, *Clostridium oedematiens.* The latter condition is usually known as "black disease". Post-mortem examination shows bloodstained fluid in the abdominal cavity and a swollen, soft, hæmorrhagic liver.

The two drugs of value in the treatment of liver fluke are carbon tetrachloride and extract of male fern. The latter drug must be used fresh, and there is, of course, difficulty in ensuring that supplies in East Africa are really active. Carbon tetrachloride appears to be satisfactory for sheep in Kenya. The dose, 1 cc., is much smaller than that necessary to remove hookworm. Carbon tetrachloride in Europe is considered dangerous for cattle, but it is used extensively in Kenya. The dose is 4 to 6 cc. Neither carbon tetrachloride nor extract of male fern is completely effective against immature fluke and it may be necessary to give a second dose after 4-6 weeks.

Treatment should always be combined with measures to prevent reinfestation. Canalization of swampy watering places near springs is often successful and much can be done by keeping furrows and the edges of dams free from vegetation. The addition of copper sulphate to give a concentration of one part in 500,000 of water will kill off the snails.

Paramphistome flukes.—At least three paramphistome flukes are known to occur in the rumen of ruminants in East Africa. They are pale-pink, elongate objects, the longest species being about one inch long. Although they suck blood they are not of great importance in the adult stage. The immature flukes of one species, *Cotylophoron cotylophorum,* are sometimes present in great numbers in the early part of the small intestine when they may cause diarrhoea.

Blood flukes or Schistosomes.—These flukes appear to be rare in Kenya; but *Schistosoma bovis* has been collected on two or three occasions from cattle at Kabete. The males are white in colour, about ¾ inch long and have a groove along the ventral surface in which the thread-like female is carried. These parasites are found in the veins that drain the blood from the gut. Eggs are deposited in numbers in the capillaries of the gut wall which they block. They penetrate through the gut wall into the lumen and are voided in the fæces.

Tapeworms

The tapeworms found in the domesticated animals are all bisexual animals with no alimentary tract. The adult stages are found in the intestines, where they multiply by producing chains of segments in which, in course of time, eggs are produced. The eggs pass to the exterior in the fæces usually still contained in ripe segments. If after a short period they are swallowed by a suitable intermediate host, they pass to the body cavity, organs or musculature, where development and, with some species, one or more asexual multiplication cycles occur. With one group the first intermediate host is swallowed by a second intermediate host, and there is further development before the final host ingests the parasite. Eventually, however the larval or metacestode stage finds itself in the intestine of the definitive host and develops into a tapeworm.

Tapeworms of carnivores and of man.—The commonest tapeworm of dogs in Kenya is *Dipylidium caninum,* sometimes known from

the appearance of the segments as the "cucumber-seed tapeworm". The larval stage occurs in fleas and biting lice. Other species which have been found are *Mesocestoides lineatus,* the life-cycle of which is not known with certainty, *Tænia hydatigena,* the intermediate stage of which is known as *Cysticercus tenuicollis,* the large bladder worm found in the peritoneal cavity of sheep and other herbivores, and a species of *Diphyllobothrium.*

Hyaena and lion harbour species of *Tænia,* the intermediate stages of which occur almost certainly in ruminants. A related genus *Echinococcus* must occur in carnivores in East Africa, for whilst the very small adult worms have not been collected, the large metacestode stage, the so-called "echinococcus cyst" is found not infrequently in the liver or lungs of cattle and sheep.

Of the tapeworms of man, *Tænia saginata* and *T. solium* call for mention, since their intermediate stages are the so-called "measles" of cattle and pigs respectively.

For the treatment of tapeworms in dogs, arecoline hydrobromide is usually satisfactory. The dose is $\frac{1}{8}$ grain for a small dog, $\frac{1}{4}$ grain for dogs larger than a fox terrier. The dog should be dosed before feeding in the morning and then walked out on a lead until the worms are passed.

No method has as yet been devised for killing the intermediate stages of tapeworms in the living intermediate host. Control must be effected, therefore, by treating the final host and in the case of "measles" by providing, and insisting on the use of, a sanitary type of latrine by all the human population of the farm.

Tapeworms of Herbivores.—The tapeworms of horses, cattle and sheep belong to the family Anoplocephalidæ. The life-cycle of the members of this family was for long a mystery; but it is now known that the metacestode stage of several, including the common *Moniezia expansa* of sheep, goats and cattle, occurs in small free-living mites found on pastures.

One species, *Stilesia hepatica,* is found in the bile-ducts of the liver of sheep. It produces some thickening of the walls of the ducts, but is not responsible for serious symptoms.

Two species of *Anoplocephala* are found in horses, mules, donkeys, and zebra. They appear to be of no significance. Species of *Moniezia, Thysaniezia, Avitellina* and *Stilesia* occur in the gut of ruminants and a heavy infestation of weaner lambs leads to loss of condition and may cause mortality. A specimen of *Moniezia expansa* may attain a length of over 6 yards.

Treatment of tapeworms in lambs cannot be regarded as entirely satisfactory. Fresh male fern extract is effective but expensive. Nodular worm remedy often gives good results, but is unobtainable at present. Copper sulphate and nicotine drench is perhaps less effective, but is cheaper. The mixture is prepared by taking 30 cc. of 40 per cent nicotine tobacco-extract, 30 grams of copper sulphate, and dissolving them in 1800 cc. of soft water. The dose for lambs and kids is 15–45 cc., for calves 30–100 cc. The dose should be given before allowing to feed in the morning. It should be followed by a dose of castor oil and the lambs should be shut up for a further two hours before being turned out.

No adult tapeworms occur in the domestic pig, although both the wart-hog and bush-pig have their own particular types.

Tapeworms of poultry.—At least nine species of tapeworms have been found in the domestic fowl in Kenya. The most important of these are *Amoebotænia sphenoides, Davainea proglottina* and *Raillietina tetragona.* Of these, the first two are so small that their presence will not be detected unless special search is made. The inner lining of the duodenum (the U-shaped loop adjoining the gizzard) should be scraped with the point of a penknife and the scrapings placed on a glass slide. A large drop of water should then be added and another slide placed on the top. On squeezing gently and holding up to the light *Amoebotænia sphenoides* appear as triangular bodies, the sides of which are only $\frac{1}{8}$–$\frac{1}{4}$ of an inch long, denser and whiter than the teat-shaped villi removed from the mucosa of the gut. *Davainea proglottina* are slightly longer and narrower at the base. When causing symptoms, loss of condition and pale combs, these parasites are, of course, present in large numbers. *Raillietina tetragona* measure up to 10 inches in length. Although little thicker than a hair anteriorly, the wider, posterior segments are easily seen. The head of this species penetrates the inner layers of the gut wall and produces small nodules, visible from outside the gut. The larval stages of *Amoebotænia* are found in earthworms, of *Davainea* in slugs and *R. tetragona* in maggots.

The best method of treatment appears to be the administration of $\frac{1}{4}$ to 1 cc. of turpentine diluted with a little bland oil to each bird by stomach tube followed by Epsom salts in the mash.

(*Received for publication on 4th November,* 1943)

REVIEWS

LOCAL PASTURE PROBLEMS AS SEEN IN AN INDIAN MIRROR: A Review of "Indian grazing conditions and the mineral contents of some Indian Fodders", by P. E. Lander; Misc. Bull. No. 16, Imperial Council of Agricultural Research, India, 1942.

One of the most pressing of India's animal husbandry problems is to increase fodder supplies for her teeming live stock millions. In approaching this major problem, two outstanding obstacles are encountered (*a*) uncontrolled and excessive overgrazing of pastures by enormous herds of nondescript cattle, which results in (*b*) soil erosion and its attendant evils. In the semi-arid hilly country which supports excessively dense populations, the evils of soil erosion extend far beyond immediately obvious scoring, erosion and lowered carrying-capacity of the pastures. The hill soils and grazings sponge up the rainfall and allow slow percolation but, with the removal of soil and herbage, this safety valve controlling lower-level water supplies is lost. Consequently, rain washes away in torrents and is lost to both hilly country and plains so that periods of flood alternate with droughts and produce an ever-widening circle of destruction.

Pasture improvements will be difficult until the present excessive demands on the grazings are curtailed and many authorities advocate wholesale destruction of uneconomic animals. The author quotes from Ware the methods by which the problem should be tackled: "by means of soil and plant surveys, analyses of and feeding trials with fodder from grazing areas, the introduction of new grasses, legumes, edible shrubs, etc., the prevention of erosion by bunding, etc., the provision of a well-distributed supply of drinking water, pasture management, including controlled and rotational grazing, fencing, etc., exploring the possibilities of fodder conservation—dry storage and ensilage, and the restriction of the number of permits issued for grazing so as to allow of the proper development of the areas and the preservation of the desirable grasses". The author stresses the need for co-operation from every angle with particular emphasis on the minerals and nutritive values of fodders.

Grazing conditions are also affected by climatic and economic factors. Climate is often not sufficiently equable for extensive pasture growth. Generally the rainfall is too little, or falls too intensively in a short period so that, though growth may be luxuriant, grass quickly matures and dries off. An important economic factor is the recent concentration of attention on cash crops with the subsequent neglect of, and encroachment upon, former grazing areas. Uncultivated or natural waste lands have provided the sustenance of huge herds (and still do). These areas offer but scant grazing and often are too remote from villages to be of appreciable value. Not unnaturally the consequent malnutrition of stock, caused by ill-balance or deficiency of essential food components, has resulted in degeneration.

Though little information is available concerning the nutritive level of these waste lands, the author points out that much more information is available regarding lands administered by the Forest Department. Improvement schemes are being attempted in forest areas, and rules made to cover rotational grazing and the division of the grazings into units at the rate of 1-3 acres per head of cattle. But the work needs to be further extended in conjunction with scientific work on grass.

Even if improved, the forest grazings can exert but a trivial influence on India's vast problem of live stock improvement since only 8½ out of 97 millions of animals can take advantage of them. The figures indicate that the acreage of forest land per head of cattle varies from 1.1 to 4 acres but this includes much unsuitable forest and areas too remote from habitation, so that near villages the number per acre is unduly high and stricter control is necessary. It is accepted that two animals per acre is the minimum average that can be permitted with safety. The author points out that where grazing fees are charged they are too small and the animals are allowed to roam such large areas that effective control is not possible. The net result is an increase in the numbers of useless stock and a vicious circle develops, bringing research workers back to the original problem of reducing the numbers of uneconomic stock.

Whilst the importance of minerals is now understood by all animal nutrition workers and in spite of the work already done, the information on Indian fodders is far from complete. The author instances the good Punjab pastures supporting good cattle types whilst poor animals are found on deficient grazings, and points out that foreign importations of stock have met with little success. He suggests that more promising results would follow in the indigenous herds from controlled breeding and feeding—particularly feeding.

Not only must grazings supply adequate amounts of each mineral, but the ratios between minerals must be balanced. The mineral contents of grasses varies with the degree of maturity and with locality. Con-

siderable variations have already been reported and the author stresses the need to determine whether these variations are roughly constant for a particular grass species or locality, or whether they change with other factors. These variations must be determined as they have to be considered in assessing the relative values of different pastures and fodders. Lander urges a wider study of all nutritive factors and the need to regard the nutrition of the plant and animal as a composite and interdependent whole.

The main portion of the bulletin gives analytical data for many fodders and grasses collected from the author's 20 years' work in the Punjab and from analyses made by workers in other provinces. He points out that pasture improvement is often a question of the salvage or repair of natural grazings ruined by mismanagement. He suggests several methods of dealing with different types of grassland and for the drier areas he advises, in the first years, contour bunding with delayed grazing or cutting until the grasses have seeded.

Turning to the analytical data, the author draws attention to an interesting effect of mineral status on the nutritive value of fodders, though this point needs further confirmation. With fodders and hays the results suggest that higher phosphate contents were accompanied by higher digestible protein values. In sub-maintenance fodders low phosphate and crude protein values were recorded, so that in such fodders phosphate assimilation was low with a wide calcium/phosphate ratio.

Since composition varies between grass species at corresponding stages of maturity, and also between different stages of maturity in the same plant, much work was undertaken to determine grass compositions at different stages of maturity and from different localities for a large number of species. It is not worth while to discuss here the relative values of these Indian grasses, but to consider only the general principles.

Advancing maturity causes a gradual decrease in the crude protein, phosphate, potash and calcium values, though the calcium decrease is less regular. With systems of monthly cutting (to simulate grazing conditions), the crude protein and mineral contents usually showed much less tendency to decrease as the season advanced. Whilst certain specific differences were noted, monthly-cut grass produced a continuous supply of nutritious fodder through the season. When the interval between successive cuttings was extended to two or more months, the new growth maintained a higher crude protein and mineral composition than when the same grasses were allowed to mature.

In one place the author states that this large volume of information "is but an introduction to a vast field of research which remains to be organized and explored", and serves merely as a starting place for other work.

For East African readers, the value of this bulletin lies not so much in the wealth of analytical data as in the description of the Indian problem and the suggestions as to how it should be tackled. If a few numbers and place-names were changed, parts of this bulletin would apply directly to certain East African semi-arid conditions, which support by far the largest portion of our live stock. Parts of semi-arid East Africa are badly overgrazed and eroded and ameliorative measures have to be taken. A considerable start in the study of reclaiming worn-out pastures has already been made at Mpwapwa by Staples, and probably the method of attack in East Africa is from a slightly different angle. In the Indian bulletin, great emphasis is laid on chemical and nutritional studies; in East Africa, whilst a number of more promising grass and fodder species have already been examined by French, there is far less information available on the composition and digestibility of our local grasses. This is one line along which more work will have to be done. The Mpwapwa conditions are admirably suited to the study of semi-arid pastures, and Staples has now listed the unsuitable grass species and has begun intensive studies on the more promising grasses. Grazing tests are made to find out the relative ability of the grasses to withstand grazing and trampling, whilst the condition of the animals in these tests allows of a rough assessment of relative nutritive values. By means of grazing tests, systems of pasture management, reclamation, and salvage are being studied and the results are now being gradually applied to wider areas of Tanganyika. Deferred grazing schemes in native areas have already proved their worth and will be extended.

Thus, though we may learn much from this valuable publication on Indian pasture problems and results, it does not mean that nothing is being done to put our own pastures in order. We have the same problems of overgrazing, erosion and arid climatic conditions, but we also have the extra problem of tsetse infestation. This scourge locks up large tracts of land which could be made available to stock and thereby reduce the grazing intensity on existing pastures. The problem of replacing tsetse-infested bush by pastures is also part of the programme already in hand in this territory.

Though work on grazing problems in East Africa started much later than similar work in India, and far fewer workers have devoted their energies to this important aspect of animal husbandry in East Africa, much has been achieved and a good foundation laid for the future, so that we need not be dismayed by the magnitude of the problem, nor by the more rapid accumulation of data elsewhere.

M.H.F.

Food and Folly

To all those interested in the future of East Africa I strongly recommend the July number of the *East African Medical Journal,* which deals exclusively, interesting and simply with the most important problem of feeding the community, more especially in Kenya. Some of the articles contain little which is new, but so urgent is the problem of malnutrition in East Africa that their authors need no excuse for repeating what is, or should have been, already known to every responsible person. For many years it has been realized that a great deal of ill-health, unhappiness and inefficiency in East Africa is caused by improper feeding, involving us in losses, both human and material, which we just cannot afford. If therefore the East African dependencies are to flourish after this war, our policy must be framed to ensure that every man, woman and child, white, black and brown, receives food adequate both in quantity and quality to the attainment of his, or her, full potentialities.

An article by Dr. C. R. Phillip, dealing with the nutrition of African children, shows that we are wantonly wasting our future man power by neglecting the feeding of the young. He finds, for instance, that native school children in Nairobi, a town many look on as the future hub of an East African civilization, are definitely deficient in protein, iron and certain vitamins, and are only receiving in their normal diet "about half of the minimal requirements of lime salts for the normal growth of bone". As the result of anæmia, he states, certainly 17 per cent, and probably 91 per cent, of these children have "never experienced a real sense of well-being".

The Kikuyu in the South Nyeri Reserve he finds little better off, and remarks that calcium deficiency "appears to be stunting the Akikuyu as a tribe", while other remediable deficiencies are undermining their health and vigour.

Passing on to a study of the coastal Wadigo and the pastoral Masai, here too he finds a gloomy picture of preventable disease due to improper feeding, so the reader will understand with what feeling he remarks, "Stockbreeders would quickly go out of business if they took no heed of the balanced diet necessary for the proper feeding of their animals. Human beings, however, are not bought and sold". In Dr. Paterson's notes on the present cost of foodstuffs in Kenya we get a further insight into the plight of many Africans, particularly those urban families who must needs buy all, or at least most, of their food and have to pay for rent, light, fuel, clothing, and so on. The author calculates that the cost of a "desirable minimal diet" *for one person* (*not* a family, and excluding the cost of fuel for cooking) is Sh. 11/88 per month, while a "good diet" involves an expenditure of Sh. 19/29. If these figures are correct, and I see no reason to doubt them, one cannot but conclude that East Africa cannot afford to employ natives in towns at the present low rates of pay attaching to many occupations. It is far too dangerous, politically, socially and from the health point of view.

One might reasonably expect that the plight of people so poorly fed from infancy was hopeless, but Dr. Anderson, writing on "The diet of the African soldier", demonstrates clearly what so many of us have observed, that a balanced ration as provided in the army very frequently produces spectacular results. Everyone handling recruits has been surprised at what army food can do for the African, and cannot have failed to imagine the beneficial effects on the country as a whole were the whole population to be fed on the same scale.

Hitherto nutritional workers in East Africa have aimed at providing a minimal ration, but the experience gained with native troops, combined with other work elsewhere, convinces me that this, though naturally the first objective, does not take us nearly far enough. We must aim at an optimal ration if we wish to secure optimal health and efficiency, and I am convinced that such a policy is both economically and politically sound.

Dr. Paterson in his article "Health and Agriculture", which many will have heard as a broadcast talk, takes up this matter. He points out how serious are the white employer's losses from unskilled and inefficient labour, adding "It is impossible to visualize the extent of the effect that a well-fed and contented peasantry would have on the economy of the Colony".

Many employers of labour, notably the mining companies in South Africa and also an increasing number of East African employers, realize that poor feeding is poor economy, and feed their labour well because, as one Rand

compound manager said to me, "We can't afford to feed them worse!" But important and economically sound though the proper feeding of labour undoubtedly is, maximum efficiency can never be attained until the sources of labour, the native areas, are adequately fed too. To do this, as Dr. Paterson points out, involves a marked general improvement in agricultural methods, which in turn demands an expansion of agricultural education.

Unfortunately, even in native areas, vested interests often stand in the way of progress, and as Mr. A. B. Killick stresses in his article on agricultural development in these areas in Kenya, rational plans for the future must wait on the "settlement of problems associated with land tenure and land inheritance". In an able article he points out that our knowledge of native land law and agronomics is insufficient for the purpose, and urges the importance of research along these lines.

I do not think I interpret Mr. Killick wrongly when I say he appears to feel with so many of us that native law and custom should be modelled on agronomic considerations, and not vice versa, and that the sanctity of immemorial tradition is frequently a lethal factor under modern conditions.

Mr. Killick thinks that "in general . . . . . it appears certain that in native areas future development must take two main forms", either "smallholdings . . . . embracing areas of both cultivated and pasture lands sufficient to provide the family with an adequate and balanced diet and a reasonable purchasing power", or "communal farming", the former developing "in the more fertile areas of high rainfall", the latter in "the poorer areas of lower rainfall" where conditions make impossible the relatively high standard of cultivation necessary to successful smallholding.

Many would disagree that the possibilities are so limited, and there are certainly signs in many parts of East Africa of a system arising which is intermediate between the two, because the environment necessitates it. It should not be forgotten either that in places where soil types vary greatly within a small area, as so frequently occurs in many parts, smallholdings of the type Mr. Killick describes involve a high degree of agricultural specialization quite foreign to most tribes, and that even if this is desirable, it may take several generations to bring about.

Mr. Killick ends his article by insisting on the necessity of maintaining the fertility of the soil, the ultimate source of all food, an oft-repeated and oft-ignored precept it behoves *all* agriculturists never to forget.

Dr. D. Harvey, in two articles, "A note on the place of nutrition in state planning" and "Notes on the rationing of foodstuffs", shows how a biochemist can help in framing state policy. He maintains in the words of Professor Bernal that "anarchic private interests on the one hand or stupid bureaucracy on the other can destroy most of the potential value that might accrue from technical advances", which is as true in East Africa as anywhere else. He makes a plea for properly planned production of food, and indicates lines on which this should be done, stressing the "fundamental importance" of regarding all the inhabitants of East Africa "as human beings irrespective of whether they possess black, brown or white skins", and pointing out that, except for the action of light, skin colour, so far as is known, "has no influence whatever upon the quantitative relationships existing between any other physiological processes".

He, like Mr. Killick, insists on the importance of a balanced agriculture with improved animal production, and sounds a note of warning regarding the export of grain, which presumably he considers could in the long run be more profitably fed to stock. He calculates that in 1939 in maize exports alone fertility equivalent to 4,407 tons of fertilizers was shipped out of Kenya, an unbalanced process which many realize cannot continue without bringing ruin.

The July *East African Medical Journal* shows without a doubt the suicidal methods employed in the past, and stresses the need for more and more education of the public to a realization of their peril. This is difficult when the bulk of it is illiterate, but it can be done, and the closing article, "Taking the horse to the water", by Dr. Paterson, illustrates the sort of methods which may prove successful with Africans. The article, which is illustrated, describes an experiment in popularizing Irish stew amongst a section of the Akikuyu, and will, combined with Dr. Anderson's account of feeding African troops, go a long way towards refuting those who have maintained that the Africans' feeding habits are almost unchangeable.

The July number's almost exclusive preoccupation with Kenya should, however, not be interpreted by the reader to mean that the urgency of the problem is not also realized in other East African dependencies where there are workers only too eager to resume wholeheartedly their fight against malnutrition, and merely waiting for the war to end, when they hope their respective Governments will give them the opportunities they need. A.T.C.

(*Received for publication on 7th September*, 1943)

CORRESPONDENCE

The Agricultural Research Station,
Kawanda, P.O. Box 265, Kampala.
24th September, 1943.

The Editor, East African Agricultural Journal

Sir,

Dr. Nattrass' note "To hoe or not to hoe" in the July number of *The East African Agricultural Journal* raises a question of cultivation in which I have been interested for some time, particularly in respect of *robusta* coffee, and which I have discussed in a recently completed paper; the paper is too long for this journal, but I hope that it will be published elsewhere. *Robusta* coffee grows wild in many forests of Uganda, often in swampy hollows; the wild trees always have a very shallow root system, with strong lateral roots arising from the trunk of the tree close to ground level, and spreading to considerable distances just below the surface of the ground; many of the feeding roots of the wild trees are not in the soil at all, but are in the thin layer of fallen leaves lying on top of it.

If the wild trees had so superficial a root system, where would the roots be when the crop is cultivated? That is the question which I have tried to answer in my paper, giving measurements of the lengths of roots found in soil cores taken at different depths in the soil. These figures showed that usually at least half of the feeding roots were to be found in the top three inches of soil, if the ground had not been disturbed. The concentration of roots near the surface of undisturbed ground may be very great; one sample, 10 sq. cm. in area, taken to a depth of 1 cm., contained 226 cm. of roots, that is, 22.6 cm. of root per cc. of soil.

Any cultivation of the soil will lead to the destruction of a great part of the root system of the plants. If there is no growth of weeds, cultivation is quite unnecessary in the case of *robusta* coffee, as is shown by the flourishing condition of the old coffee trees, some of them over one hundred years old, to be seen near African house in Uganda and in the Bukoba district of Tanganyika; no weeds grow beneath these trees and the soil beneath them has not been disturbed for many years; and the trees continue to be in good health.

An attempt has been made to copy the indigenous method of cultivation on one of the coffee plots at the Kawanda Experimental Station; the trees are of the indigenous strains, they are widely spaced (15 feet apart) and trained to form large spreading trees; and they are not subjected to any pruning of the branches; cultivation is reduced to a minimum to avoid disturbance of the roots. The soil is not rich, and the climate is rather too dry for *robusta* coffee; yet the yields for the last two years have been about 16 cwt. and 12 cwt. per acre, and another heavy crop is now ripening. The lack of cultivation does not seem to have produced any bad result on the coffee or on the soil; the site of the plot is on a slope gullied under native plots before the coffee was planted; the system of no cultivation, coupled with the construction of bunds at vertical intervals of three feet, has completely controlled soil wash, for there is such a mat of roots in the surface soil that the rainfall of heavy storms is quickly absorbed.

Not only *robusta* coffee, but also most of the other important tropical woody crops—*arabica* coffee, para rubber, cacao, tea and cinchona—are forest plants in the wild state. Plots of these crops also have been sampled and it was found that in each case the roots tended to be in the upper layers of soil; it was only in the case of *arabica* coffee and of cinchona that a considerable portion of the roots were at depths below six inches.

The effect of cultivation on tea has been studied in India and Ceylon and it has been found to depress the yields of leaf; an annual deep forking through the tea used to be an established part of estate routine in north India, but it is being generally discontinued; if pernicious grasses are present, they are dug out, but otherwise cultivation is reduced to the minimum necessary to control weeds.

It has been stated that cultivation increases the permeability of the soil, so that air and water may enter it more rapidly. Eden, who studied the effect of cultivation on tea in Ceylon, found that it had no significant effect on the permeability of the soil. The figures which I have collected in Uganda suggest that cultivation may even make the soils less permeable, for the plots which were most easily penetrated were those which had not been disturbed for many years, in which the roots had been able to make unchecked growth.

Samples of the roots of other non-woody tropical crops—plantains, sugar cane, maize, pigeon pea, and cotton—showed that there was no concentration of the roots in the surface soil, but that most of them were at some depth in the ground. As these crops originated from

wild plants whose natural habitat was not in forests, this result was not surprising. And, on account of the great differences between the root systems of woody and non-woody crops, it is possible that their reactions to soil cultivation may be very different.

Yours faithfully,

A. T. THOMAS,
Senior Economic Botanist, Uganda.

M'Gunga Farm,
P.O. Rongai, Kenya Colony.
21st November, 1943.

The Editor, East African Agricultural Journal

Sir,

Congratulations on your October issue and especially to Mr. Edwards on his Rhodes Grass article, which is most interesting and instructive.

May I ask him if anyone has tried planting the seed with, and at the same time as, the last wheat crop is planted before going back to grass? I presume it is a good deal slower than wheat and I do not think it would affect the wheat yield. Some years ago in West Australia I used to plant, through the wheat drill and with the wheat, a species of subterranean clover which gave good results when the sheep were turned into the stubble after harvesting.

May I also ask if Mr. Edwards has tried, or would try, top-dressing the pasture? And again try turning sheep on to the plots after the cattle have finished wih it? If sheep are put on after cattle, at the rate of, say, 50 sheep to the acre, and kept on until they have eaten everything there is to eat, and this is followed by a harrowing and then a *spelling* (resting), then I think the resulting yield of seed will be increased and there will be fewer bare patches.

As to the last paragraph of the article, I do not think there is any necessity to take a hay crop off before cattle are put on (unless of course you want the hay). If sheep are used instead and put on at the same rate and only left on for a short time, this would have a mowing as well as a top-dressing effect.

F. B. HEWSON

Note by D. C. Edwards

Experience of Nzoia Rhodes grass does not yet extend to its establishment under wheat, but this is a matter which it should be easy to settle, and I think that, within the climatic conditions given for the grass in the article, there would be every chance of success. It would not be feasible, however, to sow the grass seed through the wheat drill, as this would result in its being sown too deeply. A special attachment for grass seed would be necessary.

Top-dressing the pasture with artificial manures will undoubtedly be an advantage, if not a necessity, when intensive methods of farming are adopted, in order to replace the minerals removed by the sale of milk and meat, but it should be borne in mind that where a supplementary mineral ration is fed, a proportion of this is returned to the land, and where grazing animals are concentrated, the necessity for mineral manures is lessened. Experiments at Kabete have shown that the effect of mineral manures upon the yield of grass is small and not to be compared with that of organic manure. Further, it should be appreciated that quite apart from the opportunity which the ley provides for increasing the chemical fertility of the soil, its effect upon the physical condition is of special importance under the climatic conditions of East Africa.

Major Hewson's suggestion to use sheep to clean up the pasture after cattle is, I believe, sound, and would tend towards the maintenance of a close sward. In practice it is usual to employ a sequence of different classes of grazing animals in order to make full use of the pasture—beginning with, say, milk cows, following with dry cows and finishing with sheep.

I also agree that sheep might with advantage take the place of the mower in dealing with the first uneven growth of the grass after sowing, since these animals feed almost entirely upon leaf and would be unlikely to tear up the creeping stems as would cattle, but it would probably be found desirable to run the mower over the field after the sheep had been removed, in order to deal with the flowering stems which they would largely neglect. Major Hewson's letter is very helpful in drawing attention to the practical points of management which he discusses.